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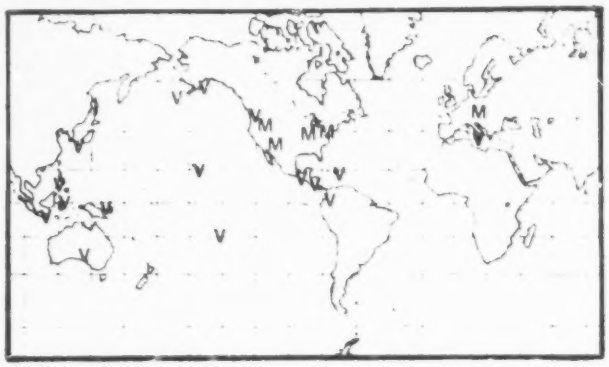

M-Meteoritic S-Seismic V-Volcanic

VOLUME 11, NO. 5, MAY 31, 1986

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Lindsay McClelland, Elizabeth Nielsen, Emily Wegert, Toni Duggan, Marjorie Summers

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VOLCANIC EVENTS

Ruiz Volcano, Colombia (4.88°N, 75.37°W). All times are local (= GMT - 5 hours). The 15 April-15 May material was inadvertently omitted from last month's Bulletin.

15 April - 15 May

A substantial increase in seismic activity began in late April and was continuing in mid-May. Seismic records suggested that a minor ash emission occurred on 4 May, and ashfalls were reported within 3 km of the summit.

Seismicity remained at moderate levels until 20 April, when there was a swarm of 37 high-frequency events, with maximum magnitudes of 2.0. On 24 April a swarm of 24 low-frequency events was apparently accompanied by an increase in the SO_2 content of the vapor column that emerges from Arenas Crater. No other eruptive changes were reported.

Harmonic tremor began on 4 May at 1300. A seismic signal with a maximum amplitude of 8 mm started at 1445 and lasted about 4 minutes, apparently marking a brief ash emission that was not directly observed. Periods of tremor of variable duration were recorded on 5, 7, 8, 9, 10, and 11 May, the longest approximately 26 hours, separated by brief quiet intervals. Tremor frequency remained relatively constant (5-6 Hertz) but amplitudes varied significantly, reaching a maximum of 20 mm on 4 May between 2243 and 2300. The beginnings and ends of tremor episodes were often gradual, but on some occasions tremor ceased suddenly. On 7 May between 0000 and 0200, a swarm of high-frequency earthquakes was detected. One event had a magnitude of more than 2.0, the largest registered at Ruiz since December 1985.

Dry tilt data showed inflation of between 2 and 15 microradians on three of the four stations, while the fourth, on the NW flank, indicated 37 microradians of deflation. Electronic tilt measurements and EDM lines showed only minor changes.

COSPEC data yielded rates of SO_2 emission that varied between 24 and 5,000 metric tons per day. However, a station that measures wind direction and intensity has failed, and the raw COSPEC data can no longer be corrected for those factors.

15 May - 15 June

Seismic activity at Ruiz, which increased significantly after 19 April, has remained dominated by harmonic tremor since 4 May. The tremor had a dominant frequency of 5 Hz, but strong components of frequencies as low as 1 Hz have been recorded at times. During a period of weak tremor on 29 May, there was a

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Ruiz Volcano (continued)

several-hour swarm of low-frequency events. About 1 day before this swarm, electronic tiltmeters began to show fluctuations, with daily changes of 1.5 microradians and periods of several hours to a few days. The pattern of all deformation measurements (EDM, dry tilt, electronic tilt, and levelling) was inflationary as of mid-June, although small and irregular (0.4 microradians per day).

After 6 weeks, harmonic tremor fell to the noise level on 14 June and the number of low-frequency events increased again. Five shallow events, with durations of up to 3 minutes, were counted. Poor visibility prevented correlations with crater activity. Tremor resumed during the evening of 16 June and was continuing the next day.

Ash emissions were evident on many days, sometimes depositing thin layers on fresh snow. When winds forced the column down, a sulfur smell was strong as far as several tens of km from the crater. During most of the few overflights permitted by weather conditions, the crater fumaroles again showed distinct behavior, with one emitting ash, the other only vapor. The most recent COSPEC data, collected at the beginning of June, showed an SO_2 emission rate of 3500-5200 metric tons per day, in contrast to previous weeks in which values fluctuated between 250 and 1200 tons per day. No significant changes to the summit ice cap were observed.

Because of the significant increase in activity, on 12 June the government released orders for permanent evacuation of a zone within 10 km of Arenas Crater (population about 1,700), and strongly recommended that the area within a radius of 10-20 km also be evacuated (population 8-10,000).

Information Contacts: Hans Jürgen Meyer (Scientist-ir-Charge), Eduardo Parra P. (Regional Director), Alberto Núñez and Fernando Muñoz, INGEOMINAS, Observatorio Vulcanológico de Colombia, Apartado Aereo 001296, Manizales, Colombia.

Tacaná Volcano, México/Guatemala border (15.13°N, 92.10°W).

Since the small phreatic explosion from a new vent on the upper NE flank 8 May (see last month's Bulletin), vapor emission has continued. Steaming increased slightly from some older fumaroles, probably because of recent heavy rains. As of late May, about 2-3 fairly large and a dozen small tectonic events were recorded daily. About 90% of the shocks were very shallow and most epicenters were within 3 km of the vent. Seismicity had declined somewhat by mid-June, while deformation and temperatures of nearby hot springs remained stable.

Information Contacts: Manuel Mena and Servando de la Cruz Reyna, Instituto de Geofísica, Universidad Nacional Autónoma de México, Ciudad Universitaria, 04510 México D.F., México.

Concepción Volcano, W Nicaragua (11.53°N, 85.62°W). All times are local (= GMT - 6 hours). The following is from Benjamin de Vries, based on observations between 4 February and 8 April.

"On 4 February at 1336, a weak eruption was observed, lasting until 1404. Another was recorded between 1542 and 1609. Pulses of ash rose to 100 m above the crater before falling on the W flank and the village of Moyogalpa, on the coast of Lake Nicaragua about 9 km W of the crater. A brown haze from the ash plume extended over the lake. A farmer said that the activity had been continuing for 10 days (since 25 January).

Concepcion Volcano (continued)

"Throughout the next 2 months, gas and occasional ash emission continued (Table 1). Activity was seen almost every time the crater was observed. Three types of activity were seen: ash eruptions, gray gas emission, and white gas clouds; often two types occurred together. The majority of material seemed to come from the S side of the crater, but a fissure N of the crater at about 1500 m altitude emitted gas during periods of vigorous activity.

Table 1: Activity observed at Concepción, 25 January-20 April

Jan.	25-30	Ash and gas reported
Feb.	4	2 short ash eruptions (100 m plume)
	5	Ash and gas (50 m plume)
	6	Ash eruption (100 m plume) then white gas emission
	7	Ash eruption and gray-white gas emission
	8	Gray gas emission
	9	Gray gas emission, changing to white in evening
	10	White gas (100 m plume)
	11	Ash eruption at midday (200 m plume)
	12-16	Low-level gray gas emission
	17-22	Continuous emission of white gas
	23	Some ash; white-gray gas emission; ash ejection at midday (50 m plume)
	24	White gas emission, decreasing through the day (<50 m), some ash
	25	Diffuse ash pulses (50 m high) in morning
Mar.	16	White gas emission around midday
	20	Ash and gas emission (50 m plume); brown haze over NW flank and lake
Apr.	1-4	Continuous white gas emission
	5-7	Stronger gas emission (100 m gray-white plume); gas descended gullies; strong smell; slight ash content
	8-20	Intermittent activity reported

"The white clouds were thought to be dominantly water vapor. The gray gas was sulfurous and could be smelled in villages 10 km away. On the W flanks, gas and ash tended to follow the major gullies. In these gullies, gas was insufferable, causing sore throats and drowsiness (CO_2?). The white gas did not produce a noticeable smell and usually disappeared a few hundred meters from the crater.

"The W side of the volcano now has a distinct zone to 3 km from the summit in which vegetation is absent or dead, surrounded by a zone of ailing plant and animal life. This has reached some hamlets above the village of San José (8 km SW of the crater), and some homes have been abandoned.

"There have been many rockfalls, small landslides, and slow-moving flows of ash and cinders on the W and S flanks. These seemed to increase in frequency in April. The SW gully has disgorged a large amount of blocky and fine material since 1983, forming a fan that has engulfed and killed 500 m² of mature forest. This activity is expected to increase when the rainy season starts in May. Mudflows and landslides are a serious possibility, especially if the eruptive activity continues (Figure 1).

"In early February, eruptions had a 30-hour periodicity and lasted for about 1/2 hour. Later, no particular pattern was detected. Within each eruption, numerous pulses occurred at different frequencies and intensities. Generally, the stronger activity had a higher frequency. High-frequency strong pulses tended to group together between longer periods of lesser activity. Ash eruptions were stronger, rising to 200 m above the crater and occurring in well-separated ($\geq$1 minute) groups of pulses."

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Concepcion Volcano (continued)

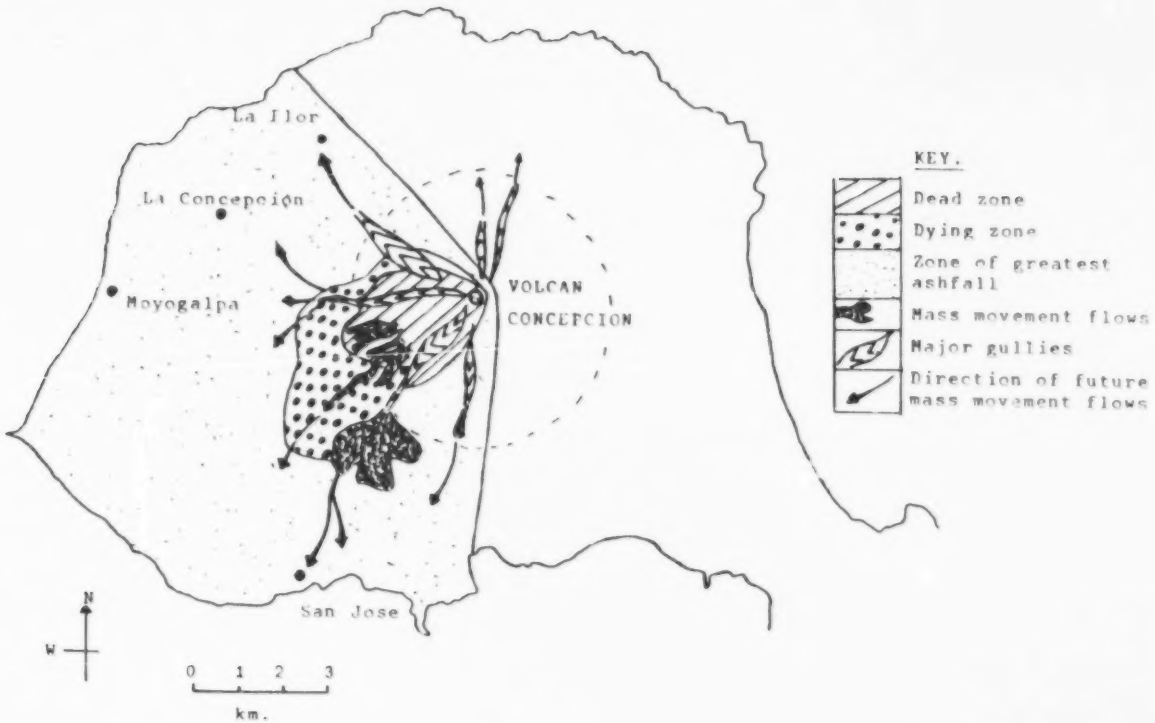

Figure 1: Map, courtesy of Benjamin de Vries, showing zones of dead and dying vegetation, ash deposition, present and possible future mass movement, and gullies at Concepción, 10 March, 1986.

Information Contacts: Benjamin Van Wyck de Vries, RHB New College, London University, Egham Hill, Surrey, England; Douglas Fajardo B., INETER, Apartado 1761, Managua, Nicaragua.

Momotombo Volcano, W Nicaragua (12.42°N, 86.53°W).

Heavy rains fell along the entire Pacific coast of Nicaragua from 30 October to 3 November 1985. Figure 2 shows that of the three highest-temperature fumaroles, the temperature of one (no. 9) dropped 33°C around the time of the heavy rains, while temperatures of the other two continued to increase slightly. The temperature of fumarole no. 9 had recovered by late December and continued to increase gradually through early April (table 2).

TABLE 2
Temperatures (°C) at Momotombo fumarole no. 9, October 1985-April 1986

Oct.	November			December			January		February		March			April	
29	11	14	20	4	11	27	15	27	20	27	6	15	23	4	10
875	842	843	861	869	871	875	875	880	880	876	875	880	882	885	885

Momotombo Volcano (continued)

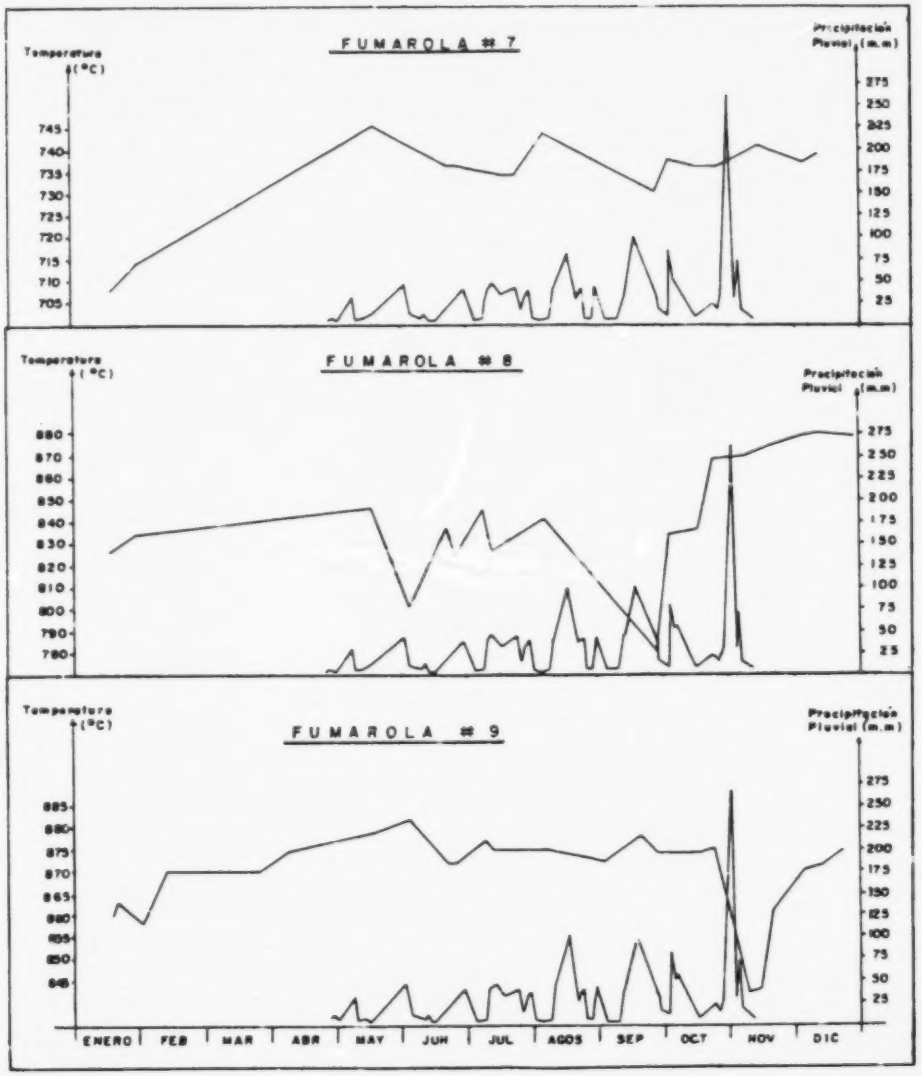

Figure 2: Temperature and precipitation data at 3 of Momotombo's fumaroles, January-December 1985. Rainfall data is from Nagarote Station, the nearest to Momotombo.

Information Contact: Douglas Fajardo B., INETER, Apartado 1761, Managua, Nicaragua.

Montagne Pelée, W Indies (14.82°N, 61.17°W).

Seismicity began on 11 December 1985, the first recorded since a well-implemented volcano monitoring network was installed in 1978. A constant low level of seismicity has been observed since December, totalling 30 events as of 4 June. Two 3-component stations were established for a month, helping to locate the shocks, at a constant depth of 1-1.5 km below the 1929 crater. Magnitudes were weak, all less than 2, and only a few were recorded at the Morne des Cadets observatory, 9 km SW of the epicentral area.

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Montagne Pelée Volcano (continued)

The seismic network is composed of 5 seismometers within 5 km of the summit. Seismic signals noted before the recent activity were attributed to surface phenomena such as rockfalls or local landslides.

Information Contacts: N. Girardin and A. Hirn, Observatoires Volcanologiques, Institut de Physique du Globe de Paris, 4 Place Jussieu, 75252 Paris Cedex 05, France; G. Boudon and J. P. Viode, Observatoire Volcanologique de la Montagne Pelée, Fonds Saint Denis, 97250 Saint Pierre, Martinique.

Kilauea Volcano, Hawaii USA (19.42°N, 155.27°W). All times are local (= GMT-10 hours).

Episode 45

Episode 45 of the E Rift Zone eruption began 7 May at 1645 with typical intermittent lava spillovers. Continuous high fountaining started at 2240, and lava flows exited from both spillways formed during the previous phase (see last month's Bulletin). The NE flows extended a maximum of 2 km and those to the SE about 4.5 km, mostly on top of previous flows. Some short flows advanced to the N and NW, forming a broad fan at the base of the cone. The "1123 cone" observation post, 1.5 km from Pu'u O'o, was again surrounded by flows.

High-amplitude tremor began on 7 May at 2242, almost simultaneously with the onset of vigorous fountaining, and ended the next day at 1106 when fountaining ceased. Subsidence began at midnight 7 May and ended exactly 16 hours later with a loss of 10.8 microradians. By the end of the month, the summit had regained 12.4 microradians of inflation.

Episode 46

During the afternoon of 1 June intermittent lava fountains were reported at Pu'u O'o. Continuous fountaining began 2 June at 0230 and ended at 1327. High-amplitude harmonic tremor began at 0240 and declined to background levels at 1309. Summit deflation totaling 11 microradians began on 1 June at 1200 and stopped the next day at 1700, 3 1/2 hours after lava production ended. Lava flowed through both the NE and SE spillways, extending a maximum distance of 5 km to the SE.

A series of very high fountain jets started at 1041, 2 3/4 hours before the end of the eruption. Jetting lasted from several seconds to about a minute, then died back briefly before fountaining resumed. Similar fountain jets were observed during episode 42 on 23 February (see SEAN Bulletin, v. 11, no. 2).

After episode 46, the summit of Pu'u O'o was 255 m above the pre-1983 surface, a growth of only 5 m since the end of 1985 (see SEAN Bulletin v. 10, no. 12). The cone is steep and the many short flows on the flanks are widening the base.

Since episode 40 on 1 January, the eruption recurrence interval has been very regular, ranging from 22-26 days.

Information Contacts: Christina Heliker, Robert Koyanagi, and Ron Hanatani, USGS, Hawaiian Volcano Observatory, P. O. Box 51, Hawaii National Park, Hawaii 96718 USA.

Kilauea Volcano (continued)

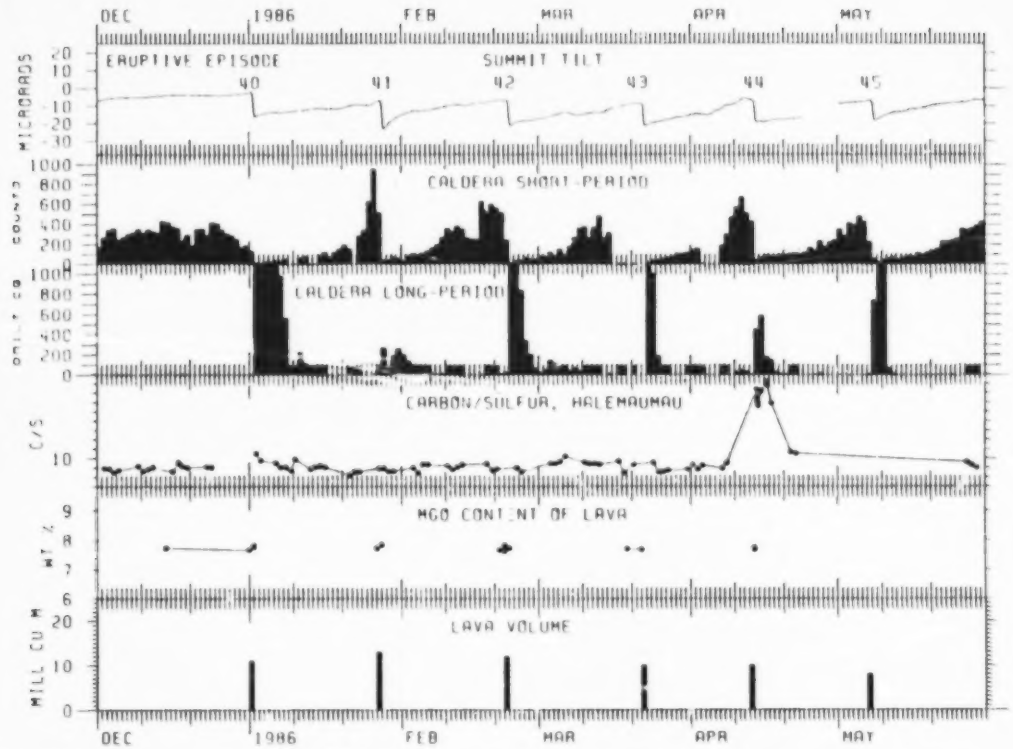

Figure 3: Six-month summary of Kilauea activity showing tilt, short and long-period caldera earthquakes, carbon/sulfur ratio of summit gases, lava volumes, and the MgO content of lavas produced prior to and during major eruptive episodes. The main summit tiltmeter is still under repair, as indicated by the break in the tilt curve, but a substitute tiltmeter has been installed to record summit deformation.

Mt. St. Helens Volcano, Cascade Range, S Washington, USA (46.20°N, 122.18°W).

During extrusion of a new lobe in early May (see last month's Bulletin), the entire dome of Mt. St. Helens deformed asymetrically, with maximum movement measured at points on the NE and S sides. A point on the top of the dome just E of the new lobe moved outward horizontally 28 m and subsided 3.2 m between 28 April and 14 May, with most of the change between 8 and 10 May. Another station at the W end of the axis of the 1985 graben moved 21.7 m. More typical displacements on the dome were 4-5 m horizontally. By approximately 26 May, deformation rates had returned to background levels.

During the dome's rapid endogenous growth, the tiltmeter on the N flank of the dome recorded about 15,000 microradians of outward tilt before going offscale on 8 May. The tiltmeter on the N crater floor recorded approximately 1000 microradians of outward tilting from 5 May to midday 8 May when the trend reversed. A large rock avalanche, consisting mainly of newly extruded dacite from the N flank of the dome, destroyed this instrument late on 9 May (figure 4). The N flank tiltmeter was reset on 14 May and recorded slow outward tilting through 11 June.

During peak activity, poor weather conditions limited successful COSPEC flights to 8 May when an SO_2 emission rate of 700 metric tons per day was measured. During

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Mt. St. Helens Volcano (continued)

the next flight, on 14 May, SO_2 emissions were down to background levels of 35±5 metric tons per day. In 5 flights between 14 May and 9 June, an average of 40±5 tons a day were measured.

Seismicity also decreased greatly after 10 May and had reached background levels by 20 May (figure 5). The last of the medium to high frequency earthquakes, typical of brittle fracture, occurred 17 May. As of 12 June there were a few low frequency, shallow earthquakes beneath the dome, but the record was dominated by avalanches off the crater wall, associated with summer snowmelt.

Figure 4: Sketch by Bobbie Myers, looking S, showing the new lava lobe extruded in May on top of the dome and the 9 May rockfall deposits on the crater floor N of the dome. Meltwater generated by the hot rockfall caused a water-rich flow to move out of the crater and down onto the Loowit Fan (see last month's Bulletin).

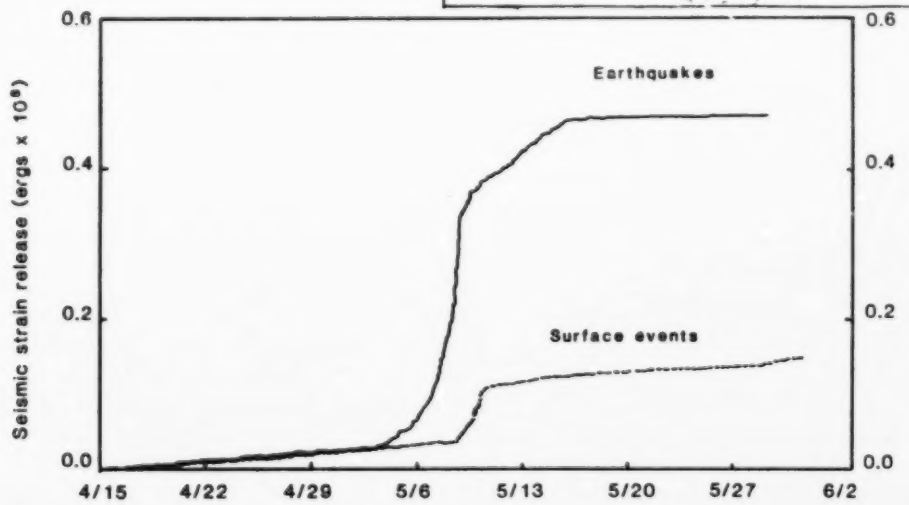

Figure 5: Cumulative seismic strain release at Mt. St. Helens, 15 April-30 May. The solid line represents earthquakes and the dashed line surface type events (steam and ash emission, avalanches).

Mt. St. Helens Volcano (continued)

Information Contacts: Donald Swanson, Dan Dzurisin, Jeff Sutton, Elliot Endo, and Bobbie Myers, USGS Cascades Volcano Observatory, 5400 MacArthur Blvd., Vancouver, Washington 98661 USA; Chris Jonientz-Trisler, Geophysics Program, University of Washington, Seattle, Washington 98195 USA.

Augustine Volcano, southwest Alaska, (59.37°N, 153.42°W).

Following the extrusion of its new dome between 22 and 28 April, activity at Augustine decreased rapidly. As of 7 June, a variable steam plume carrying small amounts of ash was still being emitted from the summit, occasionally to 3 km altitude. Scientists on the island 6 and 7 June noted an intense sulfur odor in the plume and a strong halogen smell on the pyroclastic flows. They measured a temperature of 400°C at a depth of 30 cm in a pyroclastic flow on the volcano's N flank. As of 11 June, tens of individual earthquakes were being recorded daily by the seismometer on the N flank of the volcano, indicating brittle fracturing of the cooling dome.

Information Contacts: Juergen Kienle, Geophysical Institute, University of Alaska, Fairbanks, AK 99701 USA; Betsy Yount, Branch of Alaskan Geology, U.S. Geological Survey, 4200 University Drive, Anchorage, AK 99508 USA.

Pavlof Volcano, Alaska Peninsula, Alaska, USA (55.42°N, 161.90°W). All times are local (= GMT - 9 hours through 26 April, GMT - 8 hours thereafter).

After about 10 days of increasing seismicity, Pavlof began to erupt 16 April. Samll plumes rose to less than 5 km altitude 16-17 April, before vigorous tremor accompanied the eruption of an ash column that reached about 15 km altitude during the midafternoon of 18 April (see last two SEAN Bulletins). Airplane pilots reported occasional ash emission through early June. Seismicity had decreased to background levels by 26 April but began to increase again in late May and remained vigorous as of mid-June. On 14-15 June, Thomas Miller observed strombolian activity feeding a lava flow from a new vent on the E side of the cone.

John Reeder provided additional observations of the 16-18 April eruption clouds and reports of continuing minor ash emission. On 16 April at 1117, Reeve Aleutian Airways Captain Edward Livingston noted a white steam plume rising to 4.6 km altitude over Pavlof. About noon the next day, MarkAir Captain Ray Wells reported a dark gray plume over Pavlof that rose to 4.9 km altitude and drifted to the SW over the Pacific Ocean. On 18 April at about 1130, Reeve Aleutian Captain Lee Goch saw a plume at 3 km altitude that was again drifting over the Pacific Ocean. At 1743, a jetliner crew reported to FAA Flight Control that a plume at 15.2 km altitude was drifting NE.

Weather prevented further observations of the volcano until 6 May, when Captain Goch saw a white steam plume, containing some minor swirls and streaks of gray ash, that reached 2.9 km altitude. The plume drifted NW for 1.5 km, but traces of ash could be detected several kilometers further downwind. A minor ash deposit was visible on the S flank of the volcano. At about noon on 10 May, Reeve Aleutian Flight Engineer George Wooliver observed ash on the N and NW flanks of Pavlof and the SW upper flank of Pavlof Sister, about 4.5 km to the NE. Pavlof was steaming weakly, emitting a white plume that rose no more than 100 m above the summit.

The USGS received reports from several airplane pilots of renewed activity on 30 May. At 1135, MarkAir and Reeve Aleutian pilots observed an eruption cloud rising to 4.5-5 km and drifting to the west. At 1523, an ash cloud reached about 3.5 km

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Pavlof Volcano (continued)

altitude and extended NE over Pavlof Bay. At 1604, the crew of another airliner reported "heavy smoke" that rose to about 6 km altitude and drifted NE. At 1723, white steam was being emitted to less than 3 km altitude.

John Reeder reports that on 4 June at about 1230, Captain Goch and MarkAir Captain Clint Schoenleber observed a white plume with no visible ash that rose to 4.9 km and drifted to the N. On 9 June at 1200, Captain Livingston and co-pilot Don Munson saw a gray steam and ash plume drifting 40 km to the NE. Reeder noted that Livingston's 9 June photograph suggested that a pyroclastic flow had just moved down the ESE side of the volcano and that previous pyroclastic flows had advanced down the same flank. Lee Goch's 6 May photograph and other observations suggested to Reeder that April eruptive activity had been confined to N and NE parts of the summit, depositing tephra on the NE, N, and NW sides of the volcano. Goch observed only minor steaming on 10 June.

The vigorous seismicity that had preceded and accompanied the mid-April eruption declined to background by 26 April. John Taber reported that seismicity began a gradual increase about 23 May, reached high levels by 28 May, remained vigorous through 15 June, then declined slightly.

During fieldwork near Pavlof 14-15 June, Thomas Miller observed vigorous strombolian activity from a new upper E flank vent about 150 m below the summit. Spatter rose 200-250 m above the vent, feeding an E flank lava flow that was about 100 m wide and reached about 1000 m elevation. The activity produced a small ash-poor plume fed at 5-10-second intervals. Adjacent to the new vent, the old crater was emitting steam and had enlarged somewhat since 1983.

While flying past the volcano on 16 June, James Dickson observed a 600-m ash and steam plume that was drifting toward the N. Reddish-brown ash fell from the plume.

Information Contacts: John Reeder, Alaska Division of Geological and Geophysical Surveys, P. O. Box 772116, Eagle River, Alaska 99577 USA; Tom Miller and Betsy Yount, Branch of Alaskan Geology, USGS, 4200 University Drive, Anchorage, Alaska 99508 USA; John Taber, Lamont-Doherty Geological Observatory, Palisades, New York 10964 USA.

Shishaldin Volcano, Unimak Island, Aleutian Islands, Alaska, USA (54.75°N, 163.97°W). All times are local (= GMT - 9 hours through 26 April, GMT - 8 hours thereafter). The following supplements the preliminary report in last month's Bulletin.

Large steam plumes that sometimes contained a little ash have been observed at Shishaldin since mid-March. The most vigorous activity was reported on 7 May, when a gray plume with streaks of dark ash extended 130 km S of the volcano at 3.6 km altitude. Moderate steaming was continuing in early June.

On 19 March at about 1325, James Dickson saw a yellow-brown wispy plume rise to about 90 m above Shishaldin. A nearly transparent brownish layer that extended toward the SW was visible for more than 50 km. MarkAir Captain Jerry Chisum noted another ash layer from Shishaldin on 28 March. He reported that the volcano is usually steaming from the summit, but on several occasions in the past several months he has noticed anomalously large steam plumes with traces of ash.

Captain Chisum and several other pilots observed larger than normal steam and ash emission from Shishaldin on 6 and 7 May. On both days (at 1320) the plume rose at about a 45° angle to 3400 m altitude (550 m above the summit) then drifted horizontally

Shishaldin Volcano (continued)

for at least 25 km. On 6 May the plume emission was continuous, but on the 7th the plume was puffing roughly every 20 minutes. Reeve Aleutian Airways Captain Lee Goch flew within 25 km of the volcano on 6 May at 1350, noting that the plume appeared to contain traces of ash as it had a pale gray color. His photograph showed that the plume had drifted at least 40 km to the NE at about 3600 m altitude. Aleutian Air pilot Thomas Madsen observed the plume on 7 May at about 1300. The plume extended south for at least 130 km at about 3600 m altitude. The plume had a distinctly gray tone with some streaks of dark ash. Less intense activity was reported by both Madsen and Goch on 8 May, when Madsen saw a grayish-white plume that drifted to the east. On 10 May, Reeve Aleutian Captain Edward Livingston observed only minor steaming. Similar activity, with none of the steam rising above the summit, was seen by Goch on 13 May. Two days later, he saw a 90-m plume that drifted about 4 km to the NE.

On 6 June at 1350, Captain Livingston saw a white steam plume that rose 1100 m above the summit. The next day at the same time, the plume was 1400 m high; both drifted a few km to the SE. On 9 June at 1340, the plume was only 180 m high but drifted 40 km to the E. Captain Goch noted only minor summit steaming on 10 June.

Information Contact: John Reeder, Alaska Division of Geological and Geophysical Surveys, P. O. Box 772116, Eagle River, Alaska 99577 USA.

Akutan Volcano, E Aleutian Is., Alaska, USA (54.13°N, 166.00°W). All times are local (= GMT - 9 hours through 26 April, GMT - 8 hours thereafter).

Increased steam emission from Akutan was reported on 31 December and plumes rising to estimated altitudes of as much as 5.2 km (3.9 km above the summit) have been occasionally observed since then. Ash was first visible in a plume on 18 March and numerous ash columns were seen 1-7 June. No ashfalls have been reported this year in Akutan village, 12 km E of the volcano, but fresh-looking ash was observed 5 June on the upper NE flank.

John Reeder provided additional pilot and ground observations supplementing the report of 28 April activity in last month's Bulletin. On 31 December at about 1100, James and Abi Dickson observed an anomalously large white steam plume over Akutan that did not appear to contain any ash. From Dutch Harbor airport (46 km from the volcano), the plume height was estimated at 550 m. The plume remained visible in clear, fairly calm weather until sunset, at around 1600. On 3 February at 1000, James Dickson noted a large vertical steam plume emerging from the vicinity of the volcano and by 1400, the plume height had roughly doubled. From Unalaska (47 km from Akutan), Abi Dickson estimated the plume's maximum altitude at 5.2 km, about 3.9 km above the summit. Maximum plume width was about 900 m.

On 18 March, Aleutian Air pilot Thomas Madsen observed weak but steady ejection of steam and black ash from Akutan's cinder cone. During his next overflight, on 22 March, ash ejection had stopped. The crater seemed to have enlarged slightly and appeared to be more centrally located than its previous position on the NW part of the summit. Minor steam venting was occurring from the upper and lower N and S flanks, but no steam was emerging from the central crater.

On 28 April at about 1530, Reeve Aleutian Captain Lee Goch observed a large billowing white plume over Akutan, reaching an altitude of about 2 km and extending about 8 km to the SW. By 1539, the end of the plume was 16 km SW of the volcano. Nothing unusual had been evident at Akutan when he flew past 1 1/2 hours earlier. Immediately after hearing Goch's radio report, AirPac pilot Nickol Sias flew to

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Akutan Volcano (continued)

within 300 m of the active cinder cone. A white steam column was being vigorously emitted from the cinder cone. There was no ash in the plume and no new ash deposits were evident on the cinder cone, the caldera floor, or the flanks of the volcano. Most of the cinder cone was covered with fresh snow, but fairly large circular melt areas on the N and S sides of the cone extended nearly to its base. Minor steaming was occurring from both melt areas. Two days later at 1615, Captain Goch observed a steam plume that rose only about 150 m above the volcano before drifting about 50 km to the east. On 1 May, fisherman Halvor Ostebovik noted a long brownish horizontal haze from about 16 km N of Akutan Island.

While flying at 430 m altitude just over the NW rim of Akutan caldera on 6 May at about 0920, Thomas Madsen encountered sulfur-rich volcanic gases that severely irritated his eyes. A billowing steam cloud emerged steadily from the black cinder cone. On 6 and 7 May at about 1300, MarkAir Captain Jerry Chisum saw steam plumes (with no obvious ash) rising at about a 45° angle to 1100 m height. The plume drifted WNW on the 6th and to the S on the 7th. Captain Madsen saw a very light gray plume that moved about 30 km S from Akutan about an hour before Chisum's flight on the 7th. Activity was similar just before noon the next day. At 1530, Captain Goch reported only a 30 m plume from the volcano, but noted 2 craters on the cinder cone, one north and one south of its summit. On 10 May, Captain Madsen saw very little steam emerging from the snow-free cone. No ashfalls have been reported this year in Akutan village, 12 km E of the volcano.

The USGS reports that personnel from the Trident Fisheries cannery in Akutan village observed numerous eruptive episodes in a 3 1/2-hour period on 1 June: 0715, grayish black cloud to about 3 km altitude; 0800, black cloud to 3.5 km; 0830, steam-rich cloud to 2 km; 0912, grayish cloud to 2.5 km; 0940, light-colored steam-rich cloud to 2.5 km; 1020, dense black cloud to 3.5 km; 1038, black cloud passed through weather cloud deck at 3.5 km; 1050, dense black cloud entered weather clouds at 3.5 km, the largest episode of the sequence. Weather clouds then obscured the volcano. The USGS noted that the observed activity is above background for Akutan, but not unusual.

John Reeder reported that residents of Akutan village heard booming noises during 1 June activity. At 0950, two Akutan village observers, Steve Besroches and Jamie Kase, timed the rise of an ash cloud to 2.5 km altitude at somewhat less than 2 minutes. MarkAir Captain Clint Schoenleber passed the volcano at 1200 and 1300 but detected no ash. Besroches and Kase saw ash plumes at about 1400 and 1600. Both appeared to reach about 4 km altitude and drifted slowly NE. The second plume was visible for about an hour.

Captain Madsen noted fresh-looking ash on the upper NE flank on 5 June. The next day at about 1400, Reeve Aleutian Captain Edward Livingston saw a dark vertical plume emerge from a weather cloud layer at 2.7 km altitude and rise to 4 km within about 15 seconds. On his return flight one hour later no ash was visible. The following day at about 1500 the volcano was shrouded in clouds, but a gray ash layer at 2.7 km altitude appeared to have drifted about 6 km to the ESE. That evening at about 1830, Madsen detected an 8 km-wide zone of ash that extended about 65 km E from the volcano at 1.5 km altitude.

Information Contacts: John Reeder, Alaska Division of Geological and Geophysical Surveys, P. O. Box 772116, Eagle River, Alaska 99577 USA; Tom Miller and Betsy Yount, Branch of Alaskan Geology, USGS, 4200 University Drive, Anchorage, Alaska 99508 USA.

Korovin Volcano, Aleutian Islands, Alaska, USA (52.38°N, 174.15°W). All times are local (= GMT - 9 hours).

About 10 May, James Dickson noted a 500-m vertical steam plume over the SE part of the summit. On 23 May at about 1730, Aleutian Air pilot Thomas Madsen noted a 600-m steam plume containing traces of ash rising above the rim of a 240-m deep crater in the SE part of the summit area. The increased activity was observed shortly after the 7 May magnitude 7.7 earthquake centered roughly 100 km to the SW (see Earthquake report, this Bulletin).

John Reeder and Kirk Swanson climbed the volcano in July 1983, observing only minor steaming from deep within the crater, rising to only 60 m above its floor. Plume emission has been reported from Korovin six times since 1812, most recently in 1951.

Information Contact: Same as for Akutan.

Macdonald Seamount, South-central Pacific Ocean (28.98°S, 140.25°W). All times are local (= GMT - 10 hours).

The Polynesian seismic net detected acoustic (T-phase) waves from what was described as a seismic crisis at Macdonald. The seismicity began on 16 May at 1550 with explosive activity, followed by continuous noise of variable amplitudes with episodes of higher intensity. The crisis ended 18 May at about 2100, but sporadic activity was recorded until 20 May around 0408.

This crisis is the third recorded since 1977 and the first since December 1983 (see SEAN Bulletin v. 9, no. 4). The May activity is comparable in duration and intensity to that of June 1982 (Talandier and Okal, 1984).

Reference: Talandier, J., and E. A. Okal, 1984, New surveys of Macdonald Seamount, South Central Pacific, Following Volcanoseismic Activity, 1977-1983; Geophysical Research Letters, v. 1, no. 9, p. 813-816.

Information Contact: J. M. Talandier, Laboratoire de Géophysique, BP 640, Papeete, Tahiti.

Volcanic Activity in Papua New Guinea

Rabaul Caldera, New Britain Island (4.27°S, 152.20°E).

"Seismicity at Rabaul caldera, which had increased in April, remained at a relatively high level in May with 1,532 events (1,769 in April). As in April, all of the earthquakes were quite small, the largest being an m_L 2.4. In April many shallow events occurred in the middle of the caldera, but the locations for May show a return to the normal pattern of ring-fault seismicity at depths of 1-3 km.

"Levelling measurements showed 9 mm of uplift at the SE tip of Matupit Island 7-28 May, about half the uplift rate measured in April. Tilt measurements showed small inflationary changes (0-10 microradians) in the Greet Harbour area. Electronic distance measurements showed no significant changes."

Langila Volcano, New Britain Island (5.53°S, 148.42°E).

"Crater No. 2 continued to be moderately active in May. White to gray emissions were reported daily with light ashfalls at the Cape Gloucester airstrip (10 km N of

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Langila Volcano (continued)

the summit) on 11 days. Weak rumbling noises were reported on most days with occasional explosion sounds.

"Incandescence at the summit was reported 5-8 and 11 May. The brightest glow was on the night of 7 May. During this period of increased activity, explosion sounds were heard more frequently and 10-15 explosion shocks per day were recorded on the seismograph.

"During the last 5 days of May, activity decreased; emissions were weaker and no audible noises were produced by the volcano. There was no low-frequency tremor recorded during the month."

Ulawun Volcano, New Britain Island (5.04°S, 151.34°E).

"On 10 May, unusual low-frequency events and harmonic tremor were recorded for about 3 hours. Smaller bursts of tremor lasting a few minutes each were also recorded on 13 and 15 May. There was no visible volcanic activity associated with the seismic activity, although the summit was not visible for much of this time."

Manam Volcano, off the N coast of New Guinea (4.10°S, 145.06°E).

"The activity at Manam remained at a low level in May. Weak white-to-gray emissions were observed daily from both the S and main craters, with occasional low rumbling sounds. No glow was seen from the summit area. Seismicity remained at levels similar to April, with 1000-1500 events per day."

Bagana Volcano, Bougainville Island, Solomon Islands (6.14°S, 155.19°E).

"The stronger activity that began in February continued through May. Moderate--to-strong white-to-brown emissions were reported daily. Weak glow from the summit was visible on 5 nights. There were 40-70 low-frequency seismic events per day, about the same as during the last half of April. Most of these events are probably due to rock falls from the margins of the active lava flow."

Information Contact: Peter Lowenstein, Principal Government Volcanologist, Rabaul Volcano Observatory, P.O. Box 386, Rabaul, Papua New Guinea.

Volcanic Activity in Indonesia

Iliboleng Volcano, Lesser Sunda Islands (8.34°S, 123.25°E). All times are local (= GMT + 8 hours).

Iliboleng erupted on 28 May at 1735. A single explosion ejected incandescent material and caused ashfall on a nearby plantation and several villages both E and W of the summit (Lamalota, Dua Muda, Tuawolo, and Kiwangona). The incandescent ashfalls caused grassfires in the very dry area (no rain reported since February) that burned 700 hectares of grass W of the volcano and 250 hectares to the E. About 570 people were evacuated from several villages after the initial explosion and grassfires, but returned to their homes 31 May.

On 2 June at 0500, weather had cleared and a white vapor cloud of about 100 m height was reported. B-type earthquakes were recorded in the area on 21 May, but no more seismic data was available.

Iliboleng Volcano (continued)

Iliboleng last erupted 17 November 1982, when several hours of tephra emission caused thin ashfall on some nearby villages (see SEAN Bulletin v. 7, no. 12). In August, 1983 astronauts on Space Shuttle mission STS-8 photographed a 50-70 km plume emerging from the crater (see SEAN Bulletin v. 8, no. 8).

Sangeang Api Volcano, Lesser Sunda Islands (8.18°S, 119.06°E).

Observers at Sangeang Api reported no changes in the eruption that began 30 July (see SEAN Bulletins v. 10 nos. 7-12, v. 11 nos. 1, 3 and 4). Several explosions per hour at Doro Api crater and slow growth of the lava flow continued. Only rockfall earthquakes were recorded.

Lokon-Empung Volcano, North Sulawesi (1.358°N, 124.792°E).

A small explosion 2 June at 0730 ejected a gray-colored plume to about 700 m above the crater. No other activity had been reported since a phreatic explosion on 27 April. Late March explosions emptied a small crater lake and generated mud flows (see last two SEAN Bulletins).

Semeru Volcano, East Java (8.11°S, 112.92°E).

When Semeru was visited 7-8 June, small explosions were continuing at intervals of about 5-20 minutes, producing eruption columns that rose less than 1 km. The fairly ash-rich plumes were generally carried WSW. For a few minutes after each explosion, fine ash fallout was observed around the summit area. During 3 hours of clear weather on 8 June, one nuée ardente d'avalanche was observed, about 55 minutes after the preceding explosion.

Tangkubanparahu Volcano, West Java (6.77°S, 107.60°E).

No additional seismic activity was reported, but fumarole temperatures remained elevated.

Information Contacts: Adjat Sudradjat, Liek Pardyanto, and Tom Casadevall, Volcanological Survey of Indonesia, Diponegoro 57, Bandung, Indonesia.

Canlaon Volcano, Negros Island, Philippines (10.41°N, 123.13°E). All times are local (= GMT + 8 hours).

Without any preceding seismic activity, Canlaon weakly ejected ash on 3 June at 0139. Ash reached a height of approximately 300 m above the crater rim before drifting NE. The ejection was accompanied by audible rumbling and an explosion earthquake felt at intensity I, 5.5 km SE of the crater (at Barangay Pula). The event lasted 15 minutes, 45 seconds.

Another explosion earthquake, with 18 mm amplitude, occurred at 0435; it lasted 55 seconds. From 0436 to 0500 there was moderate to voluminous emission of dirty white steam, reaching a height of 300 m and drifting NW. Ash deposits were confined to 200 m from the crater on the SE and NE slopes.

Information Contact: Office of the Director, Philippine Institute of Volcanology and Seismology, 6th Floor, Hizon Building, 29 Quezon Avenue, Quezon City, Philippines.

Sakurajima Volcano, Kyushu, Japan (31.58°N, 130.67°E). All times are local (= GMT + 9 hours).

Eight explosions were recorded in May at the summit of Minamidake, a marked decline from April, when 55 explosions were recorded (see last month's Bulletin). The May explosions did not cause any damage.

The month's highest ash cloud rose 1,000 m above the crater on 21 May at 1014. Typical bursts of micro-earthquakes occurred on 3 and 16 May.

Table 3. Daily explosions at Sakurajima in May.

Date	1	2	6	17	20	21	Total
No. of Explosions	1	2	1	2	1	1	8

Information Contact: Office of Volcanic Observations, Seismological and Volcanological Department, Japan Meteorological Agency, 1-3-4 Ote-machi, Chiyoda-ku, Tokyo 100, Japan.

Etna Volcano, Sicily, Italy (37.73°N, 15.00°E).

Since the late December end of the SE flank fissure eruption (see SEAN Bulletin v. 10, no. 12) explosive activity has continued from both central crater vents. Strombolian activity could be seen from within about 100 m of the W vent (Bocca Nuova) rim, but ejected lava fragments rarely rose above the crater rim. Active vents within Bocca Nuova varied in position and number. Since the end of April, a vent on the Southeast Crater has emitted hot pressurized gas. The Northeast Crater has been partially obstructed by internal landslides; weak fumarolic activity occurred along the crater walls.

Information Contact: Romolo Romano, Istituto Internazionale di Vulcanologia, Viale Regina Margherita 6, 95123 Catania, Italy.

Atmospheric Effects

Balloon soundings from Laramie, Wyoming (41°N, 105.5°W) on 19 May showed maximum particle concentrations of about 2.8/cm³ (radius $\geq$ 0.15 microns) at about 20 km altitude. Figure 7 plots 1971-1986 balloon data, showing perturbations associated with major eruptions.

Lidar instruments in Virginia, Hawaii, Japan, and Germany continued to detect stratospheric aerosol layers thought to be from the 13 November 1985 eruption of Ruiz. At Mauna Loa, Hawaii (19.5°N, 155.6°W), backscattering ratios of the sharp layer centered at 20.5-21 km diminished through May, while backscattering was enhanced at higher altitudes (figure 6 and table 4). Higher altitude material had first been detected over Hampton, Virginia (37.1°N, 76.3°W) on 29 April (see last month's Bulletin), and peak backscattering ratios were at 20.5-21.5 km in early June, up from 19-20 km in early May. The lower layer appeared to be weakening and did not form a distinct peak. At Fukuoka, Japan (33.65°N, 130.35°E) lidar continued to measure 2-3 layers in April and May, generally centered at altitudes of about 19 and 21-23 km, similar to March observations (see SEAN Bulletin v. 11, no. 3). From Garmisch-Partenkirchen, Germany (47.5°N, 11.0°E) peak May backscattering ratios were similar to those of April, but altitudes increased slightly.

Atmospheric Effects (continued)

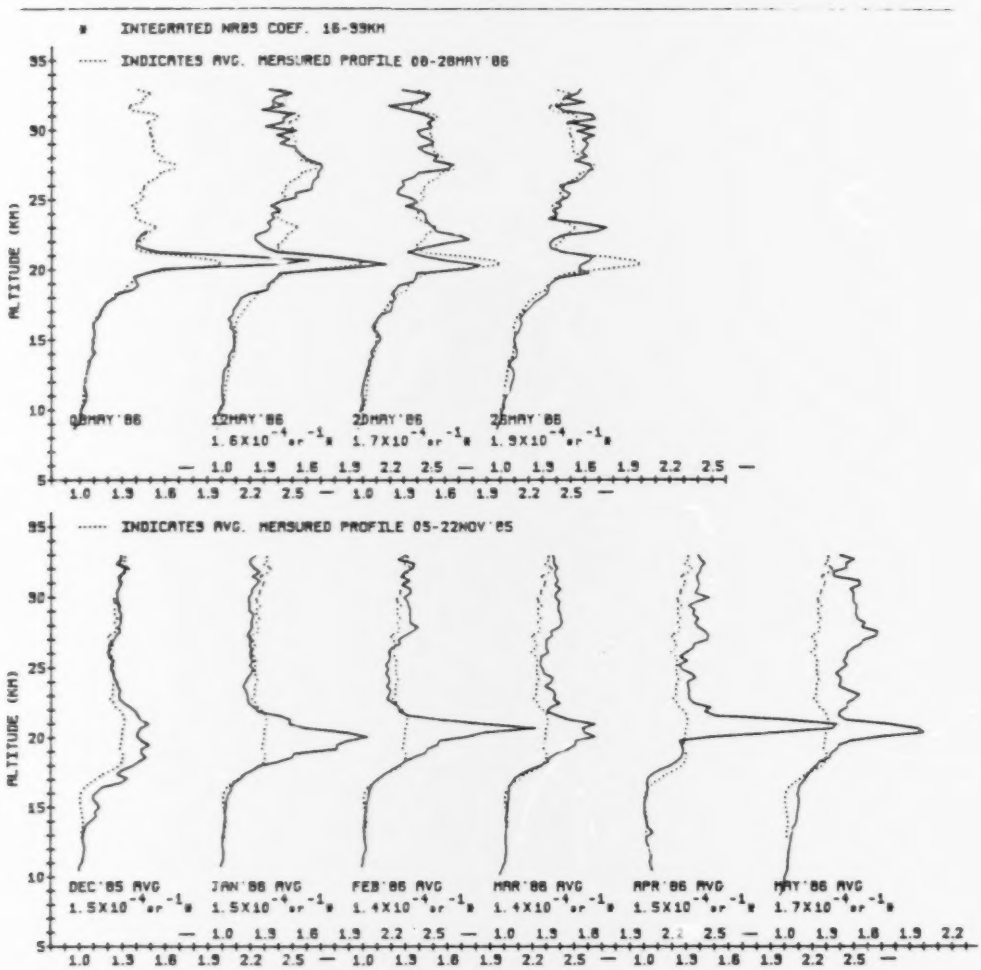

Figure 6(top): Lidar profiles from Mauna Loa, Hawaii (19.5°N, 155.6°W) 8-26 May. The dotted line superimposed on each profile represents the average May data.

(bottom): Average monthly lidar profiles from Mauna Loa, December 1985-May 1986. The dotted line superimposed on each profile represents the average 5-22 November 1985 data, before the arrival of new aerosols. Both profiles courtesy of Thomas DeFoor.

Information Contacts: David Hofmann and James Rosen, Department of Physics and Astronomy, University of Wyoming, Laramie, Wyoming 82071 USA; Motowo Fujiwara, Physics Department, Kyushu University, Fukuoka 812, Japan; Thomas DeFoor, Mauna Loa Observatory, P. O. Box 275, Hilo, Hawaii 96720 USA; H. Jäger, Fraunhofer-Institut für Atmosphärische Umweltforschung, Kreuzeckbahnstrasse 19, D-8100 Garmisch-Partenkirchen, West Germany; William Fuller, NASA Langley Research Center, Hampton, Virginia 23665 USA.

Atmospheric Effects (continued)

TABLE 4

LOCATION	DATE	LAYER ALTITUDE IN KM (peak in parentheses)		BACKSCATTERING COEFFICIENT	RATIO	INTEGRATED
Garmisch-Partenkirchen	2 May	11-27	(19.8)		1.4	
West Germany	12 May	15-26	(18.6)		1.4	
(47.5°N, 11.0°E)	22 May	11-25	(18.6)		1.3	
Hampton, Virginia	5 May	12-27	(19.8)		1.7	0.13×10^{-3}
(37.1°N, 76.3°W)	12 May	13-26	(18.8)		1.6	0.15×10^{-3}
	4 June	15-28	(21.5)		1.6	0.12×10^{-3}
	9 June	13.5-26	(20.5)		1.5	
Fukuoka, Japan	4 April	16.5-23.0	(19.1)		1.93	
(33.65°N, 130.35°E)			(22.1)		1.40	
	11 April	13.0-23.0	(19.1)		2.15	
			(22.9)		1.63	
	23 April	12.0-23.0	(16.9)		2.11	
			(19.1)		2.00	
			(22.1)		2.77	
	6 May	16.0-22.0	(19.1)		2.00	
	8 May	16.0-24.0	(19.1)		1.93	
			(22.1)		1.93	
	14 May	13.0-23.5	(18.4)		2.41	
			(21.1)		2.28	
	16 May	9.5-28.1	(18.4)		2.69	
			(21.4)		1.99	
	30 May	16.0-22.5	(19.9)		1.95	
Mauna Loa, Hawaii	8 May	16-22	(20.7)	0.61×10^{-7}	2.6	
(19.5°N, 155.6°W)	12 May	17-22.5	(20.4)	0.46×10^{-7}	2.2	0.16×10^{-3}
		22.5-29	(25.8)	0.1×10^{-7}	1.6	
			(27.3)	0.09×10^{-7}	1.7	
	20 May	16-21.5	(20.4)	0.34×10^{-7}	1.9	0.17×10^{-3}
		21.5-25	(22.2)	0.22×10^{-7}	1.8	
		25.5-29	(27.6)	0.08×10^{-7}	1.7	
	26 May	16.5-38				0.19×10^{-3}
		16.5-22	(19.8)	0.28×10^{-7}	1.6	
			(21)	0.24×10^{-7}	1.7	
		22-24	(23.1)	0.19×10^{-7}	1.8	

Table 4: Lidar data from various locations, showing altitudes of aerosol layers. Note that some layers have multiple peaks. Backscattering ratios from Fukuoka, Japan are for the Nd-YAG wavelength of 1.05 microns; from Tsukuba, Japan for the Nd-YAG wavelength of 0.53 microns; all others are for the ruby wavelength of 0.69 microns. An explanation of the relationship of ruby and Nd-YAG values is on p. 15-16 of SEAN Bulletin v. 9, no. 10. Integrated values show total backscatter, expressed in steradians^{-1}, integrated over 300-m intervals from 16-33 km at Mauna Loa and from the tropopause to 30 km at Hampton. Altitudes of maximum backscattering ratios and coefficients are shown for each layer at Mauna Loa. Mauna Loa backscattering values were truncated at 23 km on 8 May because of instrument problems. The 5 May data from Hampton replace preliminary values in last month's Bulletin.

Atmospheric Effects (continued)

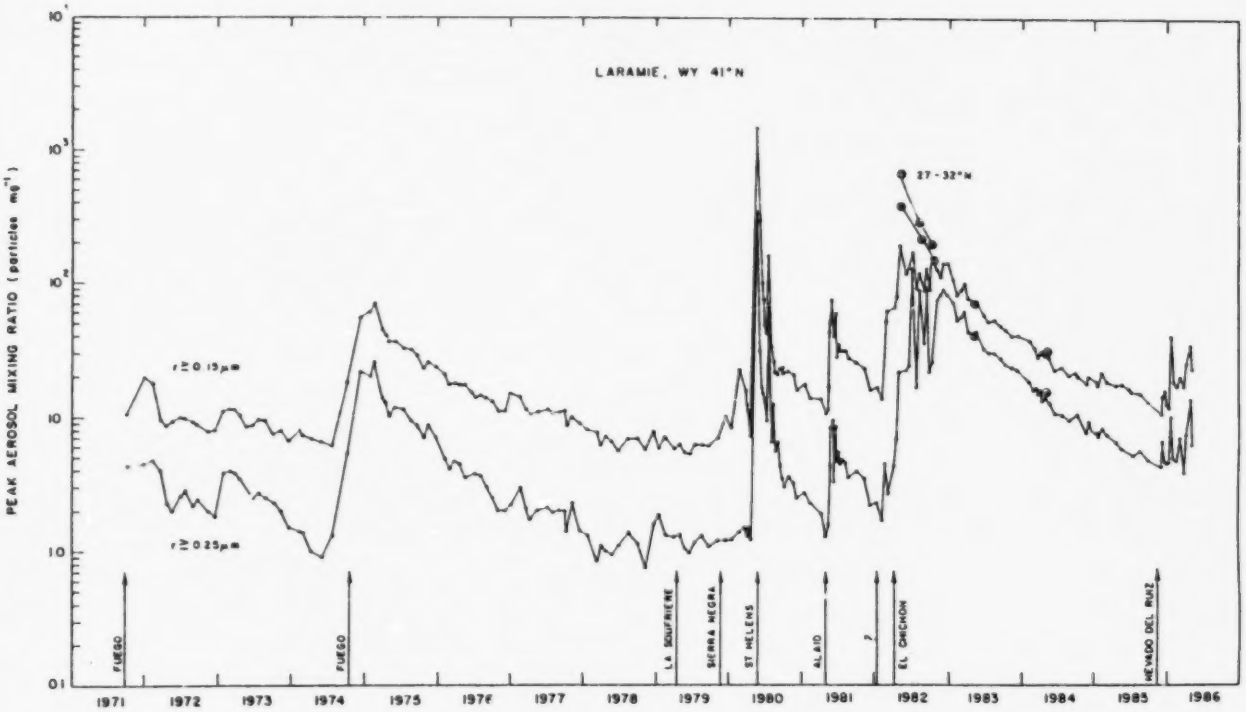

Figure 7: Aerosol mixing ratios (particles per mg ambient air) versus time at the stratospheric maximum (18-22 km) for r $\geq$ 0.25 microns and r $\geq$ 0.15 microns during 200 balloon soundings at Laramie, Wyoming and 5 in S Texas (circled crosses). The times of major volcanic eruptions believed to have perturbed the stratosphere at Laramie are indicated by arrows.

EARTHQUAKES

DATE	TIME (GMT)	MAGNITUDE	LAT.	LONG.	DEPTH OF FOCUS	REGION
5 May	0336	5.9 m_s	37.97°N	37.77°E	shallow	Turkey
7 May	2247	7.7 m_s	51.41°N	174.83°W	shallow	Aleutian Islands
13 May	0844	5.6 m_b	41.36°N	43.64°E	10 km	Turkey-USSR border
17 May	1620	6.6 m_s	52.31°N	174.57°W	shallow	Aleutian Islands
20 May	0526	6.3 m_s	24.03°N	121.60°E	shallow	Tawain
26 May	1906	6.7 m_b	20.05°S	178.78°E	570 km	Fiji Islands

The 5 May earthquake in Turkey killed 15 people, injured 100 others, and caused widespread damage in the Malatya and Adiyaman provinces. It also slightly damaged the Surgu Dam in Malatya, forcing the evacuation of surrounding villages and prompting precautionary emptying of the reservoir.

The 7 May earthquake caused some damage on Adak island, part of the Andreanof Islands. Tsunamis generated by the earthquake were about 3 m in Hawaii, 1.4 m in British Columbia, 1 m in Washington, and 1.8 m in Adak; no damages were reported.

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Earthquakes (continued)

The Turkey-USSR earthquake on 13 May was reported to have caused 2 deaths.

The second earthquake in the Andreanof Islands on 17 May was felt strongly at Adak but caused only slight damage; it was too small to generate a tsunami.

The 20 May earthquake, felt in Taipei, killed 1 person in Hualien and injured 5 others.

The Fiji Islands earthquake on 26 May caused no damage in the region.

Information Contacts: National Earthquake Information Service, U. S. Geological Survey, Stop 967, Denver Federal Center, Box 25046, Denver, Colorado 80225 USA; Washington Post, Washington, DC USA; Xinhua, Beijing, China; Associated Press; United Press International.

FIREBALLS

S Australia, 8 April, 0844 GMT (7 April, 2314 Local Time).
Observer: Douglas J. McCarty and 5 others
Location: Oakden Station, South Australia (31.25°S, 137.50°E)
First sighting: Azimuth 135° in constellation Norma, altitude 30°
Last sighting: Azimuth 180° in constellation Mensa, altitude 25°
Duration: 4 seconds
Magnitude: Twice as bright as Venus
Apparent size: 1/4 the diameter of the full moon
Color: White
Trail: White, full length of path
Train: luminous, persisted 2-3 seconds
Termination: No fragmentation
Sounds: Muted sonic booms 37 seconds after fireball passed

Information Contact: Richard N. Pugh, 4617 N.E. 26th Avenue, Portland, Oregon 97211 USA.

Czechoslovakia and W Germany, 15 April, 234901 GMT.

A slow-moving fireball of -11 maximum absolute magnitude was photographed by 3 Czech stations of the European network. The fireball travelled a 62-km luminous trajectory in 3.2 seconds. Photographs were measured by J. Bocek and all computations were performed by P. Spurny. The following results are based on all available records and should be close to final values.

	Beginning	Maximum Light	Terminal
Velocity (km/s)	22.7	21.2	7.0
Height (km)	80.47	50.8	32.3
Latitude	49.221	49.05	48.937
Longitude	13.305	13.12	13.003
Absolute Magnitude	-2.3	-10.6	-1.7
Photometric Mass (kg)	15.0	10.0	None
Z R (degrees)	38.6	--	39.0

Fireball Type: I
Member of Φ Draconid Stream

Czechslovakia (continued)

Radiant (1950.0)	Observed	Geocentric	Heliocentric
Alpha	285.6	292.0	--
Delta	67.7	67.9	--
Lambda	--	--	108.6
Beta	--	--	33.4
Initial velocity (km/s)	22.8	19.7	35.4

Orbit (1950.0)	
A	1.73 A.U.
E	0.428
Q	0.988 A.U.
Aphelion	2.46 A.U.
Omega	161.4°
Ascending Node	25.2134°
Inclination	33.6°

Information Contacts: Zdenek Ceplecha and Pavel Spurny, Ondrejov Observatory, 251 65 Ondrejov, Czechoslovakia.

Arizona, USA, 11 May, 0130 GMT (10 May, 1930 Mountain Daylight Time).
Observer: Dick Dannells
Location: Vail, Pima County (32.02°N, 110.44°W)
Path: Travelled from Cancer to Monoceros
Magnitude: Brighter than the full moon
Termination: Increased in size and flared brightly before exploding
Sounds: None reported

Information Contact: D. H. Hill, Lunar and Planetary Lab, University of Arizona, Tucson, Arizona 85721 USA.

Illinois, USA, 30 April, about 0030 GMT (29 April, 1930 Central Daylight Time).
Observer: Caesar Hill
Location: Chicago, Cook County (41.50°N, 87.45°W)
Path: E to W parallel to the horizon
Duration: 10 seconds
Apparent velocity: Fast
Magnitude: As bright as the full moon
Color: White
Trail: Luminous, 2° long
Termination: Passed into clouds while still bright
Sounds: Hum heard as fireball passed

Information Contact: Elizabeth Stiles, Adler Planetarium, 1300 South Lake Shore Drive, Chicago, Illinois 60640 USA.

Oregon, USA, 28 April, 1145 GMT (0445 Pacific Daylight Time).
Observer: Larry Watt
Location: Mitchel, Wheeler County (44.45°N, 120.08°W)
First sighting: Azimuth 355°, altitude 35°
Last sighting: Azimuth 320°, altitude 5°
Duration: 2 seconds
Apparent velocity: Slow
Magnitude: Brighter than the full moon
Apparent size: Twice the diameter of the full moon

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Oregon (continued)

Color: White
Trail: White, 15° long
Train: Crooked smoke train persisted several minutes
Termination: No fragmentation
Sounds: None reported

Information Contact: Same as S Australia.

W Pennsylvania, USA, 12 May, 0310 GMT (11 May, 2310 Eastern Daylight Time).
Observer: Yvonne Hutchinson
Location: Bairdford, Allegheny County (40.3°N, 80.0°W)
Path: From Draco toward Cassiopea
Duration: 2 seconds
Magnitude: Brighter than Jupiter
Apparent size: 3x the diameter of Sirius
Color: Yellow-orange
Trail: Yellow vapor
Termination: No explosion
Sounds: None reported

Information Contact: Yvonne Hutchinson, 49 Bairdford Road, Bairdford, Pennsylvania 15006, USA.

Virginia, USA, 30 April, 0130 GMT (29 April, 2130 Eastern Daylight Time).
Observer: Matt Dobras
Location: Springfield, Fairfax County (38.5°N, 77.2°W)
Path: SW to NE, parallel to the horizon
Duration: 1-2 seconds
Apparent velocity: Medium
Magnitude: As bright as the full moon
Color: Bright white
Trail: White
Termination: Vanished above horizon, no fragmentation reported
Sounds: None

Information Contact: Keith Stein, 7830 Water Valley Court, Springfield, Virginia 22153 USA.

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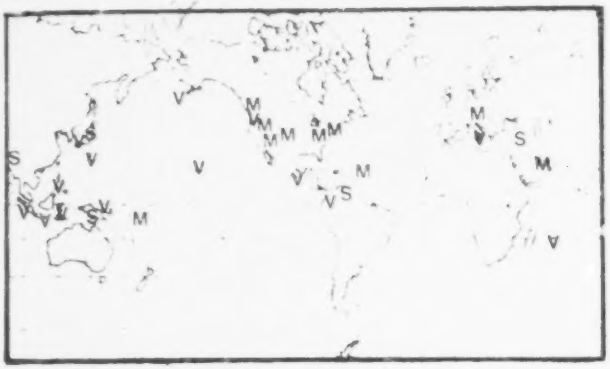
Smithsonian Institution



M-Meteoritic S-Seismic V-Volcanic

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Scientific Event Alert Network

BULLETIN

VOLUME 11, NO. 6, JUNE 30, 1986

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VL

VOLCANIC EVENTS

Ruiz Volcano, Colombia (4.88°N, 75.37°W). All times are local (= GMT - 5 hours). The following, from the Observatorio Vulcanológico Nacional, summarizes activity 15 June-10 July.

"Harmonic tremor, which started on 4 May, still dominated the pattern of seismic activity at Ruiz as of 10 July. Several times, swarm-like single event sequences of mostly low-frequency earthquakes changed the pattern for hours or even days.

"On 5 July the tremor declined almost to background level. At the same time the frequency of events increased sharply, totaling about 300 (minimum 5 second duration) by 10 July at Olleta station (4.2 km W of Arenas Crater), the highest number for a 5-day period since the 13 November eruption. The maximum magnitude was 2.2 and most events were of the low-frequency type.

"A comprehensive analysis of all deformation data (EDM, electronic tilt, dry tilt, and levelling) now clearly shows asymmetric behavior of the volcanic edifice. Most deformation data have been gathered in the NW sector and the least in the SE sector (where only one electronic tiltmeter is sensing deformation now, apparently with considerable electronic or geologic drift). However, comparison of the data sets suggests strongly that movements are most pronounced in the NW sector, somewhere between the main crater Arenas and the dormant crater La Olleta, on the W flank.

"Dry tilt station Molinos (3.2 km N of Olleta and 5.0 km NW of Arenas) recorded a fluctuating change of several tens of microradians, corresponding to upward movement in a direction E of Olleta (toward the summit) between mid-April and mid-June. There was a general agreement with this sense of deformation at Inderena electronic tiltmeter (1.1 km NE of Molinos dry tiltmeter). The start of this anomaly corresponds roughly to the reactivation of seismicity (20 April). The deformation at Molinos reversed to downward movement around 17 June, while seismic activity continued.

"A comparison of all EDM lines also reveals that deformation is concentrated in the NW sector (line Arbolito). New EDM lines and dry tilt stations are now being installed, to allow for more resolution of the deformation pattern.

"Ash emission seemed to be more or less continuous at one of the fumaroles in the crater. Samples of ash, taken from recent falls, were examined under the microscope. No signs of juvenile material were evident. The vapor column, although quite dense, was not seen at heights above 500 m. No correlation has been found yet between the fumarolic activity and the amplitude/period of the harmonic tremor."

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Ruiz Volcano (continued)

Information Contact: Hansjuergen Meyer, Director Científico, Observatorio Vulcanologico Nacional, INGEOMINAS, Apartado Aereo 001296, Manizales, Colombia.

Tacaná Volcano, México/Guatemala border (15.13°N, 92.10°W).

Seismicity declined after the 8 May phreatic explosion (see SEAN Bulletin v. 11, no. 4) and in early June about 1-2 events were recorded per day. In late June, the active vent continually emitted steam, typically to about 500 m height, with a noise like a jet engine. The vent, about 20 m in diameter, was located at the foot of a 30-m cliff along an apparent radial fault extending from the summit. Poor access prevented direct gas sampling, but a weak odor of H_2S was noted in the vicinity of the cloud. An apron of muddy, clay-rich debris surrounded the vent. Samples of February ejecta examined under a microscope were strongly altered. May and June material was less altered, but no glass was evident in any of the samples. Residen of the area who experienced the last activity in 1949-50 reported that the 1986 seismicity seemed stronger and the vent developed much more suddenly. The 1949-50 activity, on the upper SW flank, occurred from numerous small fumaroles rather than from a single vent and was apparently shorter-lived (Mullereid, 1951).

Vigorous monitoring efforts by scientists in México and Guatemala continue. Contingency plans have been prepared by the state government of Chiapas México, and a hazards assessment and map were produced under the auspices of Guatemala's Instituto Nacional de Sismología, Vulcanología, Meteorología, e Hidrología (INSIVUMEH) (Rose and Mercado, 1986).

References: Mulleried, F.K.G, 1951, La Reciente Actividad del Volcán de Tacaná, Estado de Chiapas, a fines de 1949 y principios de 1950; Depto. de Prensa y Turismo, Tuxtla-Gutierrez, México, 28 p.

De la Cruz Martínez, V., and Hernández Zuñiga, R., 1986, Geología del Volcán Tacaná; Geotermia, Revista Mexicana de Geoenergía, v. 2, no. 1, p. 5-21.

Rose, W.I. and Mercado, R., 1986, Report on UNDRO/OFDA Mission to Tacaná Volcano Guatemala/México; INSIVUMEH, Guatemala, 30 p. + 3 maps (in English or Spanish).

Information Contacts: William I. Rose, Department of Geology and Geological Engineering, Michigan Technological University, Houghton, Michigan 49931 USA; Eddy Sánchez B., Edgar Quevec R., and Enrique Molina C., INSIVUMEH, 7a. Avenida 14-57, Zona 13, Guatemala City, Guatemala; Stephen Malone, Geophysics Program, University of Washington, Seattle, Washington 98195 USA.

Kilauea Volcano, Hawaii, USA (19.42°N, 155.27°W). All times are local (= GMT - 10 hours).

After 21 days of quiet, intermittent activity resumed at Pu'u O'o at 1600 on 23 June. For nearly 2 days, spatter and lava spillovers remained within the flat area around the conduit, or moved just over the edge of the spillway. Intermittent fountaining began 25 June at 1400, giving way to sustained fountaining of episode 47 at 0419 the next morning. Fountaining ended the same afternoon, and reached maximum heights of 225 m.

During the last 2 hours of activity there were 3 high fountain jets, about 50 minutes apart, that lasted several seconds, similar of those of previous episodes (see SEAN Bulletin v. 11, nos. 2 and 5). Theodolite measurements of these jets,

Kilauea Volcano (continued)

obtained for the first time, gave maximum heights of 550 m. Intermittent fountaining occurred the last 20 minutes of the episode, ending at 1635.

Three main flows were generated, two extending 2.4 km S and 3.6 km SE mostly over previous lava flows, and one 2.5 km to the N that burned some trees. During episode 47, the cone increased 2 m in height, to 257 m above the pre-1983 surface.

Gradual subsidence of the summit commenced at 1000 on 25 June and changed to rapid decline about 0400 the next morning, just before the onset of sustained fountaining. Summit subsidence ended at 1900 with a total loss of 11.1 microradians. By 30 June the summit had regained 5 microradians. Sustained high-amplitude tremor started at 0257 on 26 June and ceased at 1614.

Information Contacts: Christina Heliker, Robert Koyanagi, and Ron Hanatani, USGS, Hawaiian Volcano Observatory, P. O. Box 51, Hawaii National Park, Hawaii 96718 USA.

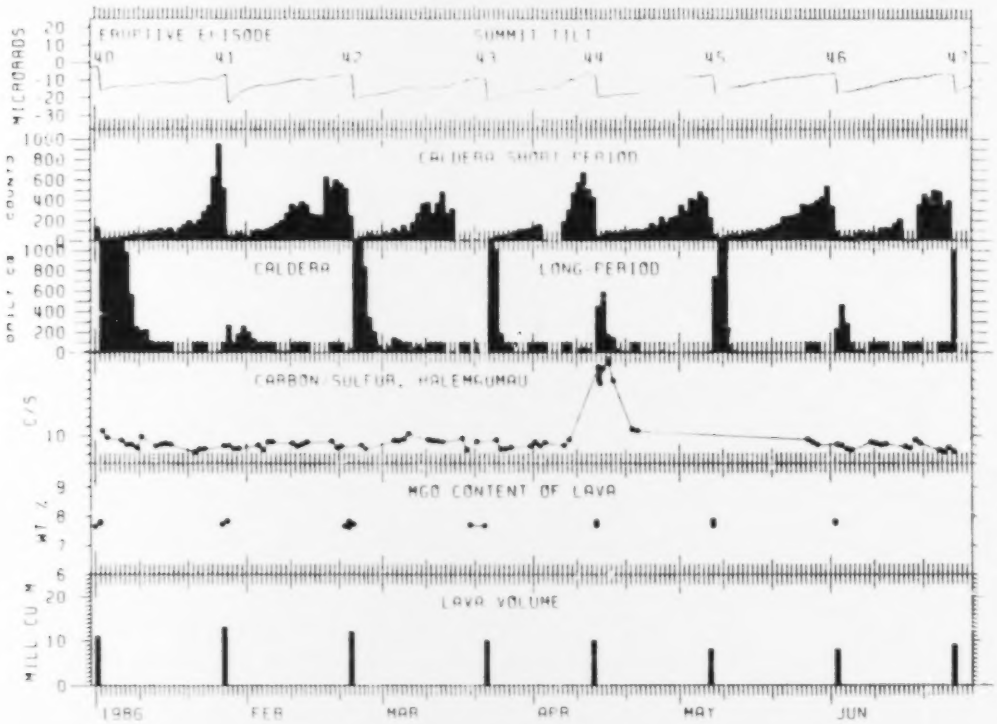

Figure 1: Six-month summary of Kilauea activity showing tilt, short-and long-period caldera earthquakes, carbon/sulfur ratio of summit gases, lava volumes, and the MgO content of lavas produced prior to and during major eruptive episodes. The main summit tiltmeter is still under repair, as indicated by the break in the tilt curve, but a substitute tiltmeter has been installed to record summit deformation.

Mt. St. Helens Volcano, Cascade Range, S Washington, USA (46.20°N, 122.18°W).

Deformation, SO_2 emission, and seismicity remained at background levels through early July. EDM lines monitoring the dome's summit area and N and W flanks showed maximum deformation rates of 2-3 mm per day. Continuously recording tiltmeters detected no unusual changes. Seismicity remained at low levels. Seismic instruments

Mt. St. Helens Volcano (continued)

recorded a few episodes in which several shocks occurred within a minute. Some events were felt by geologists working on the crater floor and one episode was associated with unconfirmed reports of plume emission. Similar activity has been recorded during previous inter-eruption periods. COSPEC monitoring on 3 days in June yielded only background SO_2 emission rates of 15-25 metric tons per day.

Information Contacts: Donald Swanson, Elliot Endo, and Steven Brantley, USGS Cascades Volcano Observatory, 5400 MacArthur Blvd., Vancouver, Washington 98661 USA; Chris Jonientz-Trisler, Geophysics Program, University of Washington, Seattle, Washington 98195 USA.

Pavlof Volcano, Alaska Peninsula, Alaska, USA (55.42°N, 161.90°W). All times are local (= GMT - 8 hours).

USGS personnel observed strombolian activity from a new vent E of and about a hundred meters below the summit during fieldwork in the area 10 June-1 July. Activity was similar on each of 7 occasions when the volcano was clearly visible. Spatter from the vent fell on the upper E flank, feeding a lava flow that had reached about 1100 m altitude by 15 June and had advanced to about 600 m altitude 2 weeks later. On 29 June, the flow was about 100 m wide at 750 m altitude. Some mudflow activity (2-3 lobes) was associated with the lava flow. Occasional moderate ash emission occurred but the largest ash columns rose only several hundred meters above the vent. On the NNE side of the summit, the vent that had been active for the past 15 years had enlarged, probably during the April eruption, but was only steaming in June. A lava flow fed by spatter from the old vent, probably in April, was snow-covered. Thick April ashfalls were sampled NW of the volcano, and large April mudflows and significant flooding were evident.

When John Reeder flew past Pavlof on 8 July at 1500, ash ejection fed a plume that reached about 3900 m altitude and drifted approximately 15 km WSW. Lava flows were seen on the SE and N sides and black ash covered the summit area.

Seismicity had begun a gradual increase 23 May and reached high levels by 28 May, remaining vigorous through 16 June. It declined slightly 17 June, but was still strong as of 4 July. No harmonic tremor was recorded. Seismicity was stronger on GMT days 28 June and 1 July than other days between 17 June and 4 July, but USGS personnel did not observe significant fluctuations in eruptive activity.

Information Contacts: Thomas Miller, Branch of Alaskan Geology, USGS, 4200 University Drive, Anchorage, Alaska 99508 USA; John Taber, Lamont-Doherty Geological Observatory, Palisades, New York 10964 USA; John Reeder, Alaska Division of Geological and Geophysical Surveys, P. O. Box 772116, Eagle River, Alaska 99577 USA.

Mt. Cleveland Volcano, Chuginadak Is., Aleutian Islands, Alaska, USA (52.82°N, 169.95°W). All times are local (= GMT - 9 hours).

The crew of the ship Blackhawk, (Hap Heyden, Ron Saylor, Dave Weyl and Capt. Emil Lindal) observed eruptive activity at Mt. Cleveland on the morning of 27 May. At 0100, while some 30 km E of Mt. Cleveland, one of the crew members could see glow at the top of the volcano and smelled sulfur fumes.

From 11 km ESE of Mt. Cleveland at about 0235, Hap Heyden observed a crater about 60 m in diameter on the upper ESE flank. The back inside wall of the crater was visible. Lava rose to 30 m above the rim, then fell back into the crater. Dave

Mt. Cleveland Volcano (continued)

Weyl saw an approximately 10-m wide glowing zone that extended from the crater at least 100 m down the SE flank, probably a lava channel. The glow from the crater seemed to be pulsating substantially. As the Blackhawk headed SW, at about 0450, Ron Saylor detected a fog-like cloud that irritated his eyes and throat. They did not emerge from the fume cloud until they were south of Herbert Island, about 25 km SSW of the volcano. No ash was detected on the boat.

Tom Madsen and John Reeder flew within 40 km of Mt. Cleveland on 10 July at about 1845 and 2115, observing minor steaming from the SE summit. Black ash blanketed the upper 650 m of the volcano, while the lower slopes were still covered with white snow.

Information Contact: John Reeder, Alaska Division of Geological and Geophysical Survey, P. O. Box 772116, Eagle River, Alaska 99577 USA.

Makushin Volcano, Unalaska Is., Aleutian Islands (53.90°N, 166.93°W). All times are local (= GMT - 9 hours).

On 28 April at 0700, James Dickson observed a 450 m vertical steam plume over Makushin that trailed SE for at least 30 km. He detected no ash in the plume. Steaming at Makushin is almost continuous, but the plume heights normally do not exceed 100 m. A small eruption in 1980 deposited ash in the summit area (see SEAN Bulletin v. 5, no. 7).

Information Contact: Same as for Mt. Cleveland.

Sakurajima Volcano, Kyushu, Japan (31.58°N, 130.67°E). All times are local (= GMT + 9 hours)

Twelve explosions from the summit crater of Minamidake were recorded in June, increasing from 8 in May (see table 1). A total of 131 explosions were recorded January-June 1986.

TABLE 1

DATE	3	5	6	10	12	17	24	25	27	30	Total
EXPLOSIONS	1	2	1	1	1	1	1	2	1	1	12

Table 1: Daily frequency of explosions at Sakurajima Volcano, June 1986.

Lapilli from an explosion on 10 June at 1100 broke windshields of 3 cars near the volcano; another windshield was broken on the 12th at 1024. Ash from the explosion on 12 June fell heavily at Kagoshima City (population 520,000), 10 km W of the volcano. Lapilli or blocks from the explosion on 24 June at 0912 broke windshields on 8 cars and damaged roofs of about 30 houses near the volcano.

A TOA Domestic airlines DC9 with 152 passengers and a crew of 6 flew into the 24 June cloud at 1200 m altitude, 23 minutes after it was ejected. Cockpit windshields and front surfaces of wings were badly scratched by ejecta. The airliner, enroute from Fukuoka, landed safely at Kagoshima. Damages to planes flying through volcanic clouds have occurred 8 times near the volcano in the past (see table 2).

Sakurajima Volcano (continued)

TABLE 2

Date	Time	Damage
1975 Apr. 8	1419	ANA airliner (L1011). Windshields cracked.
1977 Dec. 25	0859	ANA airliner (L1011). Windshields cracked.
1978 Dec. 4	1155	ANA airliner (L1011). Windshields cracked.
1979 Nov. 18	0742	2 ANA airliners (L1011) at 0801 and at 0805. Windshields cracked
1979 Dec. 18	2118	ANA airliner (L1011). Windshields cracked.
1979 Dec. 24	1740	TDA airliner (YS11). Windshields cracked.
1982 Nov. 23	1532	Nauru Air passenger plane (B727). Windshields cracked.
1986 June 24	0912	TDA airliner (DC9). Windshields scratched.

ANA: All Nippon Airways, TDA: Toa Domestic Airlines.
Times are for explosions, rather than aircraft damage.

Information Contact: Office of Volcanic Observations, Japan Meteorological Agency, 1-3-4 Ote-machi, Chiyoda-ku, Tokyo 100, Japan.

Fukutoku-oka-noba Volcano, Volcano Islands, Japan (24.28°N, 141.52°E).

A vigorous submarine eruption in January built a small island (see SEAN Bulletins v. 11, nos. 1-3). Airplane pilots have observed discolored seawater at the volcano during all overflights after the temporary island was eroded below sea level in late March. No eruptive activity was reported. The zone of discolored seawater was 0.3 km long on 16 April, 2 km in length on 19 May, and 25 km long on 18 June.

Information Contact: Same as for Sakurajima, and Japan Maritime Safety Agency, 5-3 Tsukiji, Chuo-ku, Tokyo 104, Japan.

Kusatsu-Shirane Volcano, Honshu, Japan (36.62°N, 138.55°E).

Monthly frequency of microearthquakes recorded at the volcano reached 96 in June, the highest since the active phase of 1982-1984. A gradual increase in seismicity began last year (figure 2).

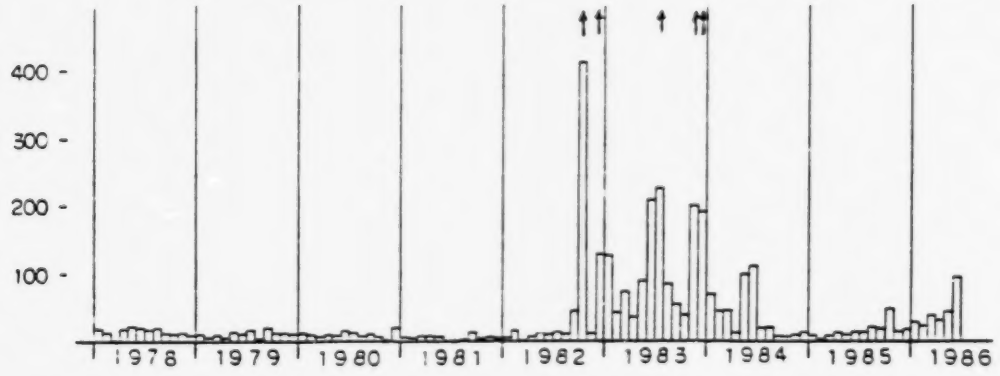

Figure 2: Monthly seismicity at Kusatsu-Shirane volcano, 1978-1986. Arrows indicate 5 eruptions in 1982 and 1983.

Information Contact: Same as for Sakurajima.

Pumice Rafts, Ryukyu Islands, Japan.

Pumice rafts have been drifting ashore in the Ryuku Islands from late May through June. Pumice was observed by JMA weather station personnel on 8 islands: Amami-Oshima, Okinawa, Kume, Minamidaito, Miyako, Ishigaki, Yonaguni, and Iriomote. More pumice has been observed on east coasts (Pacific coasts) than west coasts of the islands. The coarsest pumice was about 20 cm in diameter on Okinawa, but most of the pumice was small. On most islands, some pumice carried shellfish on the surface. No recent eruptions have been reported at volcanoes in and near Ryukyu island chain, and the source of the pumice is unknown.

Information Contact: Same as for Sakurajima.

Canlaon Volcano, Negros Island, Philippines (10.41°N. 123.13°E). All times are local (= GMT + 8 hours).

Canlaon again erupted on 21 June, almost 19 days after the previous ash ejection (see last month's Bulletin). The event started at 1907 and was characterized by a cauliflower-shaped ash-steam cloud which rose to 4000 m above the volcano's 2465-m summit. The event was initiated by an explosion-type earthquake felt with intensities III and II at seismic stations 6 and 8.7 km from the summit respectively (Cabagnaan and Canlaon). Booming and hissing sounds accompanied the ash ejection. A strong sulfurous odor was detected at Canlaon station a few minutes after the event. Field investigation the next morning showed that light ashfall had occurred on several villages SE of the summit. The maximum thickness of the wet, rainsoaked ash deposit 4.5 km from the summit was 2 mm. The maximum volume of ejected material was 136,600 m^3.

The eruption was anticipated because of the marked increase in steam volume 10 days prior to the eruption. The number of low-frequency volcanic earthquakes had remained at a high level after the ash ejection of 3 June and decreased slightly 9-13 June. Seismicity increased again on 14 June, 8 days prior to the eruption.

As of 1 July, seismicity and steaming had decreased slightly. The Philippine Institute of Volcanology and Seismicity (Phivolc) noted that other ash ejections are still to be expected based on the eruptive patterns of 1969, 1978, and 1985. Furthermore, Phivolc noted that the continued presence of low-frequency harmonic tremor, not recorded in the past at this volcano, heightens the possibility of magmatic eruption from Canlaon.

Information Contact: Raymundo S. Punongbayan, Director, Philippine Institute of Volcanology and Seismology, 6th Floor, Hizon Building, 29 Quezon Avenue, Quezon City, Philippines.

Volcanic Activity in Papua New Guinea

Rabaul Caldera, New Britain Island (4.27°S, 152.20°E).

"Seismicity at Rabaul Caldera remained at a relatively high level in June (1570 earthquakes compared to 1532 in May), although there were indications of a decline in activity in late June and early July. Ground deformation measurements in June indicated low rates of deformation.

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Rabaul Caldera (continued)

"Despite the relatively high totals of caldera earthquakes in June, daily earthquake totals appeared to be declining during the last week of the month. During the first three weeks daily totals averaged about 40-50 events, but from the 22nd, the daily average was about 20 events.

"Several small swarms of events occurred, notably in the Greet Harbour and Vulcan-Matupit Island areas. For the month as a whole, the pattern of earthquake locations shows concentrations in these areas. The strongest caldera earthquake in June was an M_L 1.9 event in the Greet Harbour swarm on the 20th.

"Tilt and horizontal distance measurements indicated that small inflationary changes were continuing in the Greet Harbour area in June. The largest tilt changes, 7 and 5 microradians, took place at the N and SE shores of the harbour. The rate of horizontal deformation was 5-10 microstrain per month.

"Levelling measurements carried out on 25 June from a traditionally stable area near the E caldera wall to the eastern shore of Greet Harbour showed maximum uplift of 18 mm (at Sulphur Point) since 8 January 1986. This indicated relatively low rates of uplift (about 3 mm/month) for this period. By comparison the maximum uplift rate on Matupit Island from late January to late May was about 10 mm/month, which is approximately equivalent to pre-crisis rates.

"Tilt measurements for the period late January to early July in the Greet Harbour area showed maximum inflationary tilts of 28 and 11 microradians at Sulphur Point and Matupit Island respectively. These tilt changes indicate rates of tilting which are reasonably consistent with the uplift rates."

Langila Volcano, New Britain Island (5.53°S, 148.42°E).

"Activity at Langila in June remained at the low level that became established in late May. Explosion sounds were heard on only 2 days (11th and 20th) and no sightings of crater incandescence were made.

"Emissions from Crater 2 were usually white vapours at low rates, but grey or brown ash emissions were noted on 11 days in the month. Fine ashfalls took place at the Cape Gloucester airstrip (10 km N of the summit) on 2 days. Seismicity was at a very low level with only a few volcanic earthquakes recorded during the month."

Manam Volcano, off the N coast of New Guinea (4.10°S, 145.06°E).

"In general, Manam's activity was at a low level in June although visible and audible activity increased somewhat in mid-month and a trend of inflationary tilt was observed throughout the month.

"During the first half of the month both craters displayed a low level of activity, emitting white and blue vapours and occasional low-density ash clouds in small quantities. Weak roaring sounds occasionally emanated from the southern crater. From the 14th, the content of ash in emissions from both craters appeared to increase, and sharper explosion sounds from the southern crater were heard until the 19th.

Information Contact: C. O. McKee, Rabaul Volcano Observatory, P. O. Box 386, Rabaul, Papua New Guinea.

Volcanic Activity in Indonesia

Sorikmarapi Volcano, North Central Sumatra (00.68°N, 99.54°E). All times are local (= GMT + 7 hours).

Sorikmarapi erupted on 5 July at 1520, when a large dark ash plume was observed from Sibangor Tonga observation post. No additional explosions were recorded on 5 or 6 July. Sorikmarapi is a strato volcano with a crater lake. The last reported activity was in 1970, when a single large ash explosion occurred.

Talang Volcano, Central Sumatra (00.98°S, 100.68°E).

Signs of enhanced activity at Gabuo Atas solfatara field were observed in May, when increased fuming was noted. The area of thermal activity has grown to cover approximately 10 hectares, but the temperatures of solfataras have remained in the normal range, between 92° and 97°C. Talang is a strato volcano without a well-defined summit crater. Solfataric activity occurrs within a 300 m valley NNE of the summit between 2360 and 2460 m altitude. The last reported eruptions were small upper NE flank explosions in 1967 and 1968.

Semeru Volcano, East Java (8.11°S, 112.92°E).

Small explosions continued from the summit crater in June, the same style of activity that has characterized Semeru since 1967.

Tangkubanparahu Volcano, West Java (6.77°S, 107.60°E).

Fumaroles in the west crater continued to have elevated temperatures. The ephemeral lake in east crater (Kawah Ecoma) has dried up, most likely the result of the end of the wet season.

Lokon-Empung Volcano, North Sulawesi (1.36°N, 124.79°E). All times are local (+ GMT + 8 hours).

Explosions in late March emptied a small crater lake and generated mud flows. Phreatic explosions were reported on 27 April and 2 June (see last 3 Bulletins). On 14 July at 1223, Lokon erupted again from Tampaluan crater (between Lokon and Empung cones), sending an eruption plume to about 1 km above the crater rim.

Sangeang Api Volcano, Lesser Sunda Islands (8.18°S, 119.06°E).

The eruption that began 30 July 1985 continued through June with several explosions per day that produced clouds reaching about 1 km above the summit. A persistent reddish glow continued to be visible at night above the main crater (Doro Api).

Information Contacts: Liek Pardyanto, Olas, Kaswanda, Adjat Sudradjat, and Tom Casadevall, Volcanological Survey of Indonesia, Diponegoro 57, Bandung, Indonesia.

Stromboli Volcano, Lipari Islands, Italy (38.79°N, 15.21°E).

Geology students from the Société de Volcanologie Genève visited Stromboli in early April and observed continued lava production. On 3 April, two vents were active in the summit terrace. Stromboolian activity at the main vent ejected tephra to 100-150 m height in explosions that occurred every 20-25 minutes. Explosions at

Stromboli Volcano (continued)

30-35-minute intervals from the second vent ejected only old material. An effusive vent in the upper NNE part of the Sciara del Fuoco (below and N of the main vent) quietly emitted two small lava flows. The main flow, about 1.5 m wide, moved N at about 0.5 m/sec; its front was about halfway down the Sciara del Fuoco. The other flow was only 0.5 m wide and was moving more slowly, to the NNE. Activity the next day was similar, but the smaller lava flow had stopped advancing. On 5 April, strombolian activity had declined; explosions were less frequent and tephra did not rise as far. One lava flow, about 2 m wide, was active, moving NNE at 1-1.5 m/sec.

Ten years of persistent mild explosive activity were interrupted in December by a vigorous eruption that produced a small pyroclastic flow and fed a lava flow that reached the sea (see SEAN Bulletin v. 11, no. 1).

Information Contact: P. Vetsch, Société de Volcanologie Genève, Case Postale 298, CH-1225 Chere-bourg, Switzerland.

Piton de la Fournaise Volcano, Réunion Island, Indian Ocean (21.23°S, 55.71°E). All times are local (= GMT + 4 hours).

A brief eruption occurred on 13 July between 1510 and 2110 from the bottom of the pit crater formed in March in the SE part of the main summit crater (Dolomieu). No activity had been reported since the end of the March-April eruptive episode, the 6th since the eruption began in June 1985.

Information Contacts: J. L. Le Mouel and J. L. Cheminee, Direction des Observatoires Volcanologiques, Institut de Physique du Globe, Tour 14, Université de Paris VI, 4 Place Jussieu, 75230 Paris ced x 05, France.

Atmospheric Effects

Lidar profiles at Mauna Loa (19.5°N, 155.6°W) varied substantially in June (figures 3 and 4; table 3). No trends were obvious but the increased integrated stratospheric backscattering coefficient observed since May persisted, apparently due to increased aerosols above about 21 km.

Thomas DeFoor reports that "Figure 5 shows the trend in integrated non-Rayleigh backscattering coefficient between January 1985 and June 1986. Integrated aerosol scattering reached its lowest value since before the 'Mystery Cloud' (20 January 1982 = 0.6×10^{-4} Sr^{-1}) on 23 May 1985 (1.0×10^{-4}) as the remnant of the El Chichón aerosol continued to decline toward the 'non-volcanic' background of 0.4×10^{-4} Sr^{-1}. However, this trend was abruptly interrupted with an increase beginning 30 May 1985. This increase and the subsequent declining trend through 22 November 1985 is judged to have been the result of an unknown 1985 eruption. Evidence strongly suggests that this injection was at least several months old at first detection and probably had a Southern Hemisphere source, as it was apparently not detected by other Northern Hemisphere lidar stations. The increased backscatter first observed 26 November 1985 was probably the result of the 13 November Ruiz eruption. The variable backscatter values that followed for the next few months are not surprising. However, the apparent increasing trend between February and June 1986 is peculiar, especially since there is no obvious evidence of post-Ruiz aerosol sources in any of the Mauna Loa lidar profiles to date."

At Hampton, Virginia (37.1°N, 76.3°W), peak backscattering ratios have declined slightly since late April but integrated backscattering has generally increased

Atmospheric Effects (continued)

(table 3). An unusually high tropopause on 9 June depressed integrated values but the remaining profile was similar in shape to others during the month. Lidar data from Firenze, Italy (43.78°N, 11.25°E) indicated a very small aerosol layer at about 20 km, with a scattering ratio (at 0.53 micron wavelength) of about 1.2-1.3.

TABLE 3

LOCATION	DATE	LAYER ALTITUDE IN KM (peak in parentheses)		BACKSCATTERING COEFFICIENT	RATIO	INTEGRATED
Mauna Loa, Hawaii (19.5°N, 155.6°W)	3 June	17-30				0.18×10^{-3}
		17-24	(21.6)	0.35×10^{-7}	2.1	
		24-30	(25.7)	0.08×10^{-7}	1.5	
			(27.3)	0.08×10^{-7}	1.6	
	10 June	16.5-34				0.14×10^{-3}
		16.5-22	(19.5)	0.21×10^{-7}	1.5	
	19 June	15-33				0.18×10^{-3}
		15-22	(21.0)	0.46×10^{-7}	2.3	
		22-24	(22.8)	0.15×10^{-7}	1.5	
			(23.4)	0.14×10^{-7}	1.6	
	24 June	13-33				0.17×10^{-3}
		16-22	(20.7)	0.43×10^{-7}	2.2	
		22-24	(22.8)	0.18×10^{-7}	1.7	
Hampton, Virginia (37.1°N, 76.3°W)	9 June	16-26	(20.6)		1.5	0.08×10^{-3}
	17 June	13.5-28	(19.5)		1.5	0.17×10^{-3}
	25 June	13.6-27	(20.0)		1.44	0.18×10^{-3}

Table 3: Lidar data from Hawaii and Virginia, showing altitudes of aerosol layers. Note that some layers have multiple peaks. Backscattering ratios are for the ruby wavelength of 0.69 microns. Integrated values show total backscatter, expressed in steradians^{-1}, integrated over 300-m intervals from 16-33 km at Mauna Loa and from the tropopause to 30 km at Hampton. Altitudes of maximum backscattering ratios and coefficients are shown for each layer at Mauna Loa. The 9 June data from Hampton replace preliminary values in last month's Bulletin.

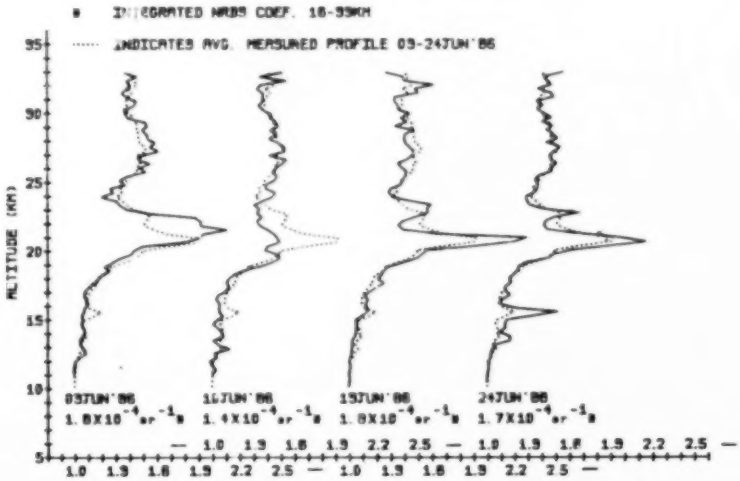

Figure 3: Lidar profiles from Mauna Loa, Hawaii (19.5°N, 155.6°W), 3-24 June. The dotted line superimposed on each profile represents the average June data.

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Atmospheric Effects (continued)

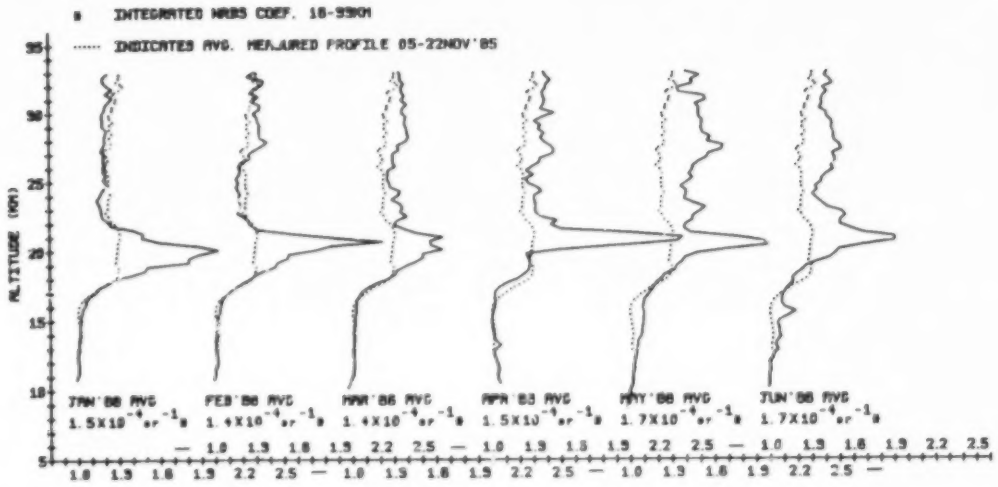

Figure 4: Average monthly lidar profiles at Mauna Loa, January-June 1986. The dotted line superimposed on each profile represents the average 5-22 November 1985 data, before the arrival of new aerosols.

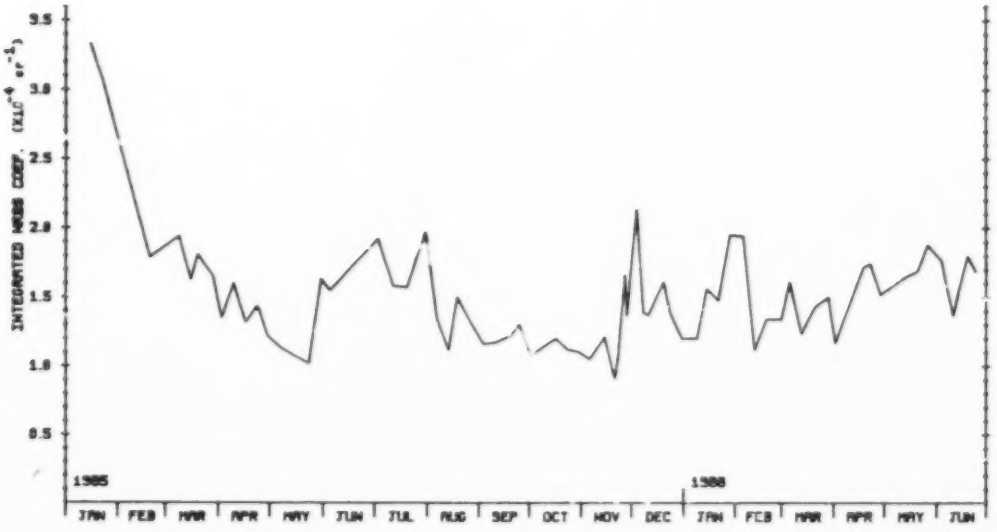

Figure 5: Integrated non-Rayleigh backscattering coefficient between 16 and 33 km at Mauna Loa, Hawaii, 15 January 1985-24 June 1986. The decline of El Chichón aerosols toward background January-May 1985 was interrupted by the 30 May arrival of aerosols from an unknown source, perhaps originating in the Southern Hemisphere several months earlier. Aerosols from Ruiz appeared in late November 1985 and a gradual increase again from an unknown source, was detected February-June, 1986. Figures courtesy of Thomas DeFoor.

Atmospheric Effects (continued)

Richard Keen observed the 24 April lunar eclipse from Auckland, New Zealand. Visual magnitude of the moon at mid-eclipse was -2.0, very close to the theoretical brightness for this eclipse, yielding a derived volcanic aerosol optical thickness of 0.00 ± 0.02. Because the moon passed through the southern part of the earth's shadow, this value is representative of the Southern Hemisphere stratosphere. The 28 October 1985 Southern Hemisphere lunar eclipse also yielded an unmeasureable volcanic aerosol optical thickness (see SEAN Bulletin v. 11, no. 1), suggesting that there had been no significant recent injections of stratospheric aerosols from Southern Hemisphere volcanoes. Stratospheric aerosols from an early 1985 Southern Hemisphere eruption suggested above by DeFoor were below the eclipse detection threshold.

Information Contacts: Thomas DeFoor, Mauna Loa Observatory, P. O. Box 275, Hilo, Hawaii 96720 USA; William Fuller, NASA Langley Research Center, Hampton, Virginia 23665 USA; Leopoldo Stefanutti, Istituto di Ricerca sulle Onde Elettromagnetiche, CNR, Via Panciatichi 64, 50127 Firenze, Italy; Richard Keen, CIRES, Campus Box 449, University of Colorado, Boulder, Colorado 80309 USA.

EARTHQUAKES

DATE	TIME (GMT)	MAGNITUDE	LAT.	LONG.	DEPTH OF FOCUS	REGION
6 June	1039	5.6 m_s	37.97°N	37.88°E	10 km	Turkey
11 June	1348	6.2 m_s	10.60°N	62.95°W	34 km	Venezuela coast
20 June	1712	6.0 m_s	30.99°N	86.73°E	shallow	Tibet
24 June	0253	6.6 m_s	34.73°N	140.50°E	48 km	Honshu, Japan
24 June	0311	7.1 m_s	4.42°S	143.98°E	121 km	Papua New Guinea

The 6 June earthquake in Turkey killed 1 person and injured 20 others. More than 100 houses were damaged in Malatya province, and new cracks formed in Surgu Dam near Dogansehir. It was felt in Adiyaman, Elazig, Sanliurfu, and Diyarbakir provinces.

The 11 June earthquake occurred near the coast of Venezuela, killing 2 and injuring 45. In Cariaco area 500 were left homeless. Damages were reported in Corupano, El Pilar, and Rio Caribe. It was felt strongly in Trinidad and as far away as Bogotá, Colombia.

In central Tibet, 58 houses collapsed and many others buildings were damaged in Wenbu District, but no injuries were reported.

The 24 June earthquake centered near the coast of Honshu triggered a brief tsunami warning. It temporarily halted air and rail services and caused power loss to more than 500 homes, but no injuries were reported.

The earthquake centered near the N coast of New Guinea on 24 June shook the highlands and Sepik regions, collapsed houses, damaged highways, caused landslides, and broke 2 sections of the submarine SEACOM cable. No reports of injuries or deaths have been received.

Information Contacts: National Earthquake Information Service, U. S. Geological Survey, Stop 967, Denver Federal Center, Box 25046, Denver, Colorado 80225 USA; Tokiko Tiba, Department of Geology, National Science Museum, 3-23-1, Hyakunin-cho, Shinjuku-ku, Tokyo 160, Japan; Ankara Domestic Service, Turkey; Lhasa Xizang Regional Service, Tibet; Japan Times, Tokyo, Japan; Kyodo Radio, Tokyo, Japan; Agence France Presse; Melbourne Overseas Service, Australia.

M. Neumann van Padang died on May 20th at the age of 92. His publications on Indonesian volcanology spanned the years 1929 to 1983, but he is perhaps best known for his leadership of the IAVCEI"s Catalog of Active Volcanoes of the World series. He completed the first catalog on Indonesia in 1951 and was soon asked to edit the full series. He authored a total of 6 catalogs and vigorously shepherded the completion of 16 more. When he resigned the editorship in 1967, at the age of 73, only 3 of the originally-planned 25 catalogs remained unfinished. Our knowledge of global volcanism owes much to his long and distinguished career.

FIREBALLS

Czechoslovakia, 8 April, 210156 GMT.

A fireball of -11 maximum absolute magnitude was photographed by 6 Czech stations of the European network. The fireball traveled a 31-km luminous trajectory in 1.6 seconds. One spectral record taken with objective grating is also available and shows mostly emissions of iron, calcium, sodium and magnesium. The following results are based on all available photographs measured by J. Bocek and should be close to final results.

	Beginning	Maximum Light	Terminal
Velocity (km/s)	20.39	19.6	18.3
Height (km)	94.19	75.4	68.72
Latitude	49.549	49.64	49.666
Longitude	14.669	14.56	14.523
Absolute Magnitude	-1.4	-10.8	-1.2
Photometric Mass (kg)	2.1	1.1	none
Z R (degrees)	33.7	--	33.8

Fireball Type: III B, Meteorite fall excluded.

Radiant (1950.0)	Observed	Geocentric	Heliocentric
Alpha	188.85	--	--
Delta	20.87	18.20	--
Lambda	--	--	131.22
Beta	--	--	8.84
Initial velocity (kms/s)	20.41	16.95	38.00

Orbit (1950.0)

A	2.70	A. U.	Omega	236.26°
E	0.698		Ascending Node	18.2413°
Q	0.8184	A. U.	Inclination	9.59

Information Contacts: Zdenek Ceplecha and Pavel Spurny, Ondrejov Observatory, 251 65 Ondrejov, Czechoslovakia.

Australia, 31 May, 1149 GMT.
Observers: Capt. Peter Dettrick
F/O John McCorkell
Location: 10°S, 172°E
First sighting: Azimuth 350°, alt. 30°
Last sighting: Azimuth 348°, alt. 20°
Duration: approximately 3 seconds
Magnitude: Dazzling.
Apparent size: Head width of full moon
Color: Very bright blue-white ball showing blue near tail
Termination: Red flashes appeared during final breakup
Train: Afterglow lasted 3 seconds
Information contact: C.S.L. Keay, Physics Department, Newcastle University, N.S.W.,2308 Australia.

Mid-Atlantic Ocean, 23 February, 0225 GMT
Observers: Captain and First Officer of Swissair SR 153 (Caracas-Zurich)
Location: 22.92°N, 58.25°W, aircraft course 72° magnetic, alt. 8.8 km
First sighting: Azimuth 78°, alt. 40°
Last sighting: Azimuth 72°, alt. 0°
Duration: 4 seconds
Magnitude: Dazzling
Color: White, then blue with yellow tail
Termination: No fragmentation reported

Pacific Ocean, 31 May, 1149 GMT
Observers: Capt. Dettrick Peter and 1st Off. John Corkell of Qantas Airways QF3 (Brisbane-Honolulu)
Location: 10°S, 172°E, aircraft course 30° magnetic, altitude 10.0 km
First sighting: Azimuth 350°, alt. 30°
Last sighting: Azimuth 352°, altitude 20°
Duration: 3 seconds
Magnitude: Dazzling
Apparent size: 3/4 diameter of full moon
Color: White
Trail: Blue, followed by red flashes during fragmentation
Train: Persisted 3 seconds, red chunks disintegrated along train
Termination: Red flashes during fragmentation

British Columbia, Canada, 13 June 0723 GMT, (0023 Pacific Daylight Time).
Observers: Several; combined reports.
Location: Vancouver (49.13°N, 123.06°W)
First sighting: SE near Altair in Aquila 25° above the horizon
Last sighting: near NE horizon
Length of travel: About 40°
Duration: 8-12 seconds
Magnitude: - 8
Color: Bluish
Termination: Broke into 2 large fragments, leading piece broke into 8 fragments, and trailing piece into 6 fragments
Information Contact: David Dodge, Gordon Southam Observatory, 1100 Chestnut Street, Vancouver B.C., V6J3J9 Canada.

Persian Gulf/Iran, 3 March, 0222 GMT
Observers: Capt. B. Balsiger, 2nd Off. R. Frey, F/Eng. F. Jegerlehner of Swissair SR 364 (Zurich-Bandar-Abbas)
Location: 25.66°N, 53.87°E, aircraft course 107° magnetic, alt. 11.2 km
First sighting: Azimuth 97°, alt. 60°
Last sighting: Azimuth 92°, alt. 10°
Duration: 2-3 seconds
Magnitude: Dazzling
Apparent size: 1/5 diameter of full moon
Color: Green

Pacific Ocean, 12 June, 1037 GMT
Observers: Capt. D. Nonamaker, 1st Off. C. Steward, 2nd Off. P. McKern, Qantas Airways QF 12-123 (Los Angeles-Tahiti)
Location: 10.09°S, 145.52°W, aircraft course 200° magnetic, alt. 10.6 km
First sighting: Azimuth 110°, alt. 90°
Last sighting: Azimuth 170°, alt. 15°
Duration: 20 seconds
Magnitude: Dazzling
Color: Bright white
Trail: Bright white
Termination: Fragmented into 3 distinct yellow-white objects that followed one another until they disappeared

Information Contact: Gerhard Polnitzky, Universitaets-Sternwarte, Tuerkerschanzstrasse 17,, A-1180 Wien, Austria.

Arizona, 23 March, 0304 GMT (22 March, 2004 Mountain Standard Time).

Observers: Christian and John Luginbuhl, Debbie Binnewies	Brian Skiff
Locations: NE ridge, Harquahalla Mtn. (33.85°N, 113.3°W)	Mars Hill (35.20°N, 111.67°W)
First sighting: about 45° altitude	Leo/Cancer border (overhead), 5-10° W of moon
Last sighting: Azimuth 48.8°, alt. 4.40°	Azimuth 122°
Duration: 2-3 seconds	3 seconds
Magnitude: maximum -8	bright as full moon
Color: green-bluish at start, turned white as it brightened, faded to yellow and orange near end	blue with orange terminal flare
Termination: flashed 4-5 times near end; several fragments separated	flared brightly into several fragments
Sounds: J. Luginbuhl heard sound as object passed; others did not	possible 1-second rumble 3 minutes after passage

Christian Luginbuhl photographed the fireball with a preset time exposure, from which he calculated the azimuth and altitude of its endpoint. His and Skiff's azimuths cross in rugged terrain about 15 km SW of Flagstaff at 35.14°N, 111.56°W.

Information Contacts: Christian Luginbuhl, U. S. Naval Observatory, Flagstaff Station, P. O. Box 1149, Flagstaff, Arizona 86002 USA; Brian Skiff, Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, Arizona 86001 USA.

Colorado, USA 23 June, 0646 GMT
(0046 Mountain Daylight Time)
Observers: Janet Intrieri, Ray Brady
Location: Boulder, Boulder County (40.0°N, 105.2°W)
First sighting: 60° alt. in NNE
Last sighting : 40° alt., dropped vertically
Duration: 3-5 seconds
Magnitude: Bright as full moon
Apparent size: 1/4 diameter of full moon
Color: Blue with white fringes
Termination: green fragments
Sounds: None reported
Information Contact: Ray Brady, NOAA/ERL, R/E/WP7, 325 Broadway Avenue, Boulder, Colorado 80303 USA.

Central Kentucky, USA, 9 May 0115 GMT
(2115 Eastern Daylight Time)
Observers: Dan and Dawn Davison
(2 fireballs sighted simultaneously from different directions)
Location: Shepherdsville, Bullitt County, (38.00°N, 85.42°W)
Paths: 1: E to W; 2: SE to NW
Duration: 1: 2 seconds; 2: 2 seconds
Apparent velocity: Both fast

Many people in central Kansas observed a fireball, the reports are summarized.
Location: Between 37.0°N and 38.5°N, 96.3°W and 97.3°W, Marion, Chase, Butler, Sedgewick, Harvey Counties
Path: Toward N from NE, downward at medium to steep angle
Duration: 2-4 seconds
Apparent velocity: Fast
Magnitude: Bright as full moon
Color: White to greenish-blue
Shape: Round to teardrop
Trail: Smoky bluish with sparks
Termination: Vanished above horizon
Information Contacts: Dave Schaeffer, Meteorologist, KAKE-TV, Wichita, Kansas 67276 USA.

Massachusetts, USA 20 May 0135 GMT
(19 May 2135 Eastern Daylight Time)
Observer: Julian Kadish
Location: Norton, Bristol County 41.58°N, 71.11°W
Path: Nearly vertical from 60° angle, covering 45°+ arc
Duration: 2-3 seconds
Magnitude: Brighter than full moon
Color: White

Central Kentucky (continued)

Magnitudes: Much brighter than Jupiter
Color: 1: Blue, red with white tail;
2: Orange and white
Trail: 1: White; 2: white
Termination: 1: Disappeared at horizon;
2: Disappeared behind trees
Information Contact: Thomas Boone, University of Kentucky, Louisville, Kentucky 40292 USA

Nevada, USA, 21 April, 0458 GMT (20 April, 2058 Pacific Standard Time).
Observer: Pete Palmer
Location: 16 km W of Austin, Lander County (39.0°N, 117.0°W)
First sighting: Azimuth 45°, alt. 50°
Last sighting: Azimuth 45°, alt. 10°
Path: W to E over the town of Austin
Duration: 2-3 seconds
Magnitude: Bright as fireworks
Color: Bright green
Termination: Disappeared over the horizon
Comment: Observer was in a car
Information Contact: Pete Palmer, Geological Society of Colorado, P.O. Box 9140, Boulder, Colorado 80301 USA.

NW Oregon, USA, 28 May, 0556 GMT (27 May, 2256 Pacific Daylight Time).
Observer: Joseph Jones
Location: Hancock Field Station, Wheeler County (44.48°N, 120.38°W)
First sighting: Azimuth 238°, alt. 22.5°
Last sighting: Azimuth 238°, alt. 15.5°
Duration: 1 second
Apparent velocity: Very fast
Magnitude: 1/4 as bright as full moon; cast shadows
Apparent size: 1/2 diameter of full moon
Color: White
Trail: Short, white
Termination: Fragmented at alt. 20.75°; a large yellow fragment, sparks fell; stayed bright as passed from view
Sounds: None
Information Contact: Richard N. Pugh, 4617 N. E. 26th Avenue, Portland, Oregon 97211 USA.

Virginia, USA, 12 April, 0035 GMT (11 April 1935 Eastern Standard Time)
Observers: Ann Lehman, Evelyn Arnold, Debra Stanley
Location: Harrisonburg, Rockingham County (38.43°N, 78.87°W)

Massachusetts (continued)

Trail: Gradually dimmed at tail
Termination: Some fragments fell away at end of path, just above trees
Sounds: None heard
Information Contact: Julian Kadish, 72 Newcomb Street, Norton, Massachusetts 02766 USA.

Oklahoma, USA, 12 June, 0300 GMT (11 June, 2100 Mountain Daylight Time).
Observer: Rob Grimmett
Location: Edmond, Oklahoma County (35.40°N, 97.30°W)
Path: NE to NNW, from alt. of 30° to 5°
Duration: 3 seconds
Apparent velocity: Fast
Magnitude: Brighter than the full moon
Color: Bright white
Trail: Luminous, pale blue, 5-8° long
Termination: Passed out of view behind trees while still bright
Sounds: None heard
Information Contact: Wayne Wyrick, Kirkpatrick Planetarium, 2100 NE 52nd St., Oklahoma City, Oklahoma 73111 USA.

NW Oregon, USA, 29 May, 0600 GMT (28 May, 2300 Pacific Daylight Time).
Observer: Dale Henderson
Location: Gresham, Multnomah County (45.43°N, 122.50°W)
First sighting: Azimuth 135°, alt. 25°
Last sighting: Azimuth 180°, alt. 20°
Duration: 2 seconds
Magnitude: Brighter than the full moon
Color: Blue-white
Trail: Short, yellow
Termination: Flared brightly at end; 2 fragments fell away; appeared to be tumbling as it disappeared above horizon.
Sounds: None heard

Virginia, USA, 29 April 0110 GMT (28 April 2110 Eastern Daylight Time)
Observers: Keith Stein
Location: Fairfax County, 38.5°N, 77.2°W
Path: E to W toward constellation of Crater
Duration: 2 seconds

Virginia (continued)

First sighting: SE, alt. 45°
Last sighting: E, alt. 20°
Duration: 3 seconds
Apparent velocity: medium
Magnitude: Bright as full moon
Color: White
Termination: Still bright as went behind trees, no fragmentation.
Information Contact: Henry Leap, Physics Department, James Madison University, Harrisonburg, Virginia 22807.

Virginia, USA, 30 April, 0342 GMT (29 April, 2042 Eastern Daylight Time).
Observer: Robert Anderson
Location: Arlington County (38.8°N, 77.3°W)
First sighting: Azimuth 235°, alt. 45°
Last sighting: Azimuth 270°, alt. 5-10°
Duration: 2-3 seconds
Magnitude: Bright enough to cast shadows
Apparent size: 10X the diameter of Venus
Color: Bright blue-white
Trail: None
Termination: Vanished above horizon without fragmenting
Information Contact: Robert Anderson, 3456-B South Utah Street, Arlington, Virginia 22206 USA.

Virginia (continued)

Apparent velocity: Slow
Magnitude: Brighter than full moon
Colors: Red and white, turned red at end
Train: White, separated at termination
Trail: White sparks lasting 2 seconds
Termination: About 15 fragments
Information contact: Keith Stein, 7830 Water Valley Court, Springfield, Virginia 22153 USA.

West Virginia, USA 26 June 0520 GMT (0120 Eastern Daylight Time)
Observer: David McWhorter
John Hovey
Location: Huntington, Cabell County (38.24°N, 82.26°W)
First sighting: Overhead, exploded at 40° from horizon
Last sighting: Fell another 20°
Duration: 2-3 seconds
Magnitude: - 8
Color: Started white, turned green as it descended
Train: White, about 50° long
Trail: Sparks falling after explosion
Sound: Muffled sound as it flashed
Termination: No fragments seen
Information Contact: David McWhorter, Rt. 3, Box 320, Procterville, Ohio 45669